INDEX

TO THE

EXECUTIVE DOCUMENTS,

PRINTED BY ORDER OF THE

SENATE OF THE UNITED STATES

FOR THE

SECOND SESSION OF THE THIRTY-SIXTH CONGRESS;

AND OF

THE SPECIAL SESSION.

1860-61.

IN NINE VOLUMES.

Volume 1 contains No. 1 part 1.
Volume 2 contains No. 1 part 2.
Volume 3 contains No. 1 part 3.
Volume 4 contains No. 2 to 13, with Nos. 1 and 2 of special session, except Nos. 6, 7, and 9.
Volume 5 contains No. 7 part 1.
Volume 6 contains No. 7 part 2.
Volume 7 contains No. 9.
Volume 8 contains Report on Commerce and Navigation.
Volume 9 contains No. 6 in quarto.

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1861.

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TO

THE EXECUTIVE DOCUMENTS

OF

THE SENATE OF THE UNITED STATES.

TABLE

OF

EXECUTIVE DOCUMENTS

PRINTED BY ORDER OF

THE SENATE OF THE UNITED STATES,

SECOND SESSION OF THE THIRTY-SIXTH CONGRESS,

1860-61.

36TH CONGRESS, 2d session. } SENATE. { Ex. Doc. No. 9.

REPORT

OF

THE SECRETARY OF WAR,

COMMUNICATING,

In compliance with a resolution of the Senate, Lieutenant Michler's report of his survey for an interoceanic ship canal near the Isthmus of Darien.

FEBRUARY 15, 1861.—Read and ordered to lie on the table. Motion to print referred to the Committee on Printing.
FEBRUARY 16, 1861.—Committee discharged. Ordered to be printed.

WAR DEPARTMENT, *February* 13, 1861.

SIR: I have the honor to transmit herewith a communication from the chief topographical engineer, accompanied by the report of Lieutenant Michler, of his survey for an interoceanic ship canal near the Isthmus of Darien, called for by a resolution of the Senate of June 5, 1860.

Very respectfully, your obedient servant,

J. HOLT,
Secretary of War.

Hon. J. C. BRECKINRIDGE,
President of the Senate.

BUREAU OF TOPOGRAPHICAL ENGINEERS,
Washington, February 13, 1861.

SIR: I have the honor of transmitting herewith a copy of the report of Lieutenant N. Michler, corps of topographical engineers, of the survey of an interoceanic ship canal near the Isthmus of Darien, *via* the Atrato and Truando rivers, called for by a resolution of the Senate of June 5, 1860.

Respectfully, sir, your obedient servant,

I. I. ABERT,
Colonel Corps Topographical Engineers.

Hon. J. HOLT,
Secretary of War.

I.

ORDERS, INSTRUCTIONS, PLAN OF OPERATIONS, &c.

List of Papers.

WAR DEPARTMENT,
Adjutant General's Office, Washington, July 9, 1857.

Special Orders No. 100.]

1. First Lieutenant N. Michler, Corps of Topographical Engineers, will hold himself in readiness for duty, with the "exploration and verification of surveys, already made, of a ship canal near the Isthmus of Darien," and will receive special instructions for his government from the War Department.

* * * * * * *

By order of the Secretary of War.

S. COOPER, *Adjutant General.*

First Lieut. N. MICHLER,
Washington City, D. C.

ADJUTANT GENERAL'S OFFICE,
Washington, July 13, 1857.

SIR: The duty to which you were assigned by Special Orders No. 100, of the 9th instant, from this office, having been placed under the general control of the Secretary of the Navy, the Secretary of War directs that you will report in person to that officer for instructions, and render such coöperation, in carrying into effect the intentions of Congress respecting the service for which you have been selected, as it may be in your power to afford.

Very respectfully, your obedient servant,

S. COOPER, *Adjutant General.*

First Lieut. N. MICHLER,
Corps Topographical Engineers, Washington, D. C.

WASHINGTON, *July* 14, 1857.

SIR: Special Orders No. 100, of the War Department, dated Washington, July 9, 1857, directed me to hold myself "in readiness for duty connected with the exploration and verification of surveys, already made, of a ship canal near the Isthmus of Darien," and subsequent instructions of the 13th instant read as follows: "The duty to which you were assigned by Special Order No. 100, of the 9th instant, from this office, having been placed under the general control of the Secretary of the Navy, the Secretary of War directs that you report in person to that officer for instructions, and render such coöperation, in carrying into effect the intention of Congress respecting the service for which you have been selected, as it may be in your power to afford."

In obedience to these instructions, I have the honor to report to you in person, and would respectfully submit the accompanying papers as a plan of operations, a list of instruments, and an estimate for carrying on the work.

I am, sir, very respectfully, your obedient servant,

N. MICHLER,
Lieutenant Topographical Engineers U. S. A.

Hon. ISAAC TOUCEY,
Secretary of the Navy.

WASHINGTON CITY, D. C., *July* 14, 1857.

SIR: I have the honor to submit for your consideration the following as a plan of operations for conducting the survey of a ship canal, connecting the Atlantic and Pacific oceans, across the Isthmus of Darien, in accordance with section 10 of the act of Congress, approved March 3, 1857, and styled "An act making appropriations for the naval service, for the year ending 30th of June, 1858." Section 10 reads as follows: "And be it further enacted, that the Secretaries of War and of the Navy be authorized, under the direction of the President, to employ such officers of the Army and Navy as may be necessary for the purpose, to make exploration and verification of the surveys, already made, of a ship canal near the Isthmus of Darien, to connect the waters of the Pacific and Atlantic by the Atrato and Truandó rivers: *Provided*, That the expense shall not exceed twenty-five thousand dollars, which are hereby appropriated therefor, out of any money in the Treasury not otherwise appropriated."

This plan will necessarily embrace the organization of a party, its personal strength and pay both for field and office-work; the necessary supplies and a sufficient equipment of arms and ammunition for its protection whilst engaged in the field; the requisite transportation to and from the scene of labor, and that best adapted for conducting the work; the probable duration of time for completing the field and office-work; the necessary instruments for making an instrumental survey for establishing the line and deciding upon the practicability of a canal; the best season of the year for operating with a proper regard for the

maintenance of the health of those engaged in that portion of the tropical regions; the data to be gained to solve all hydraulic questions; the obtaining of all information bearing upon the solution of any problems of engineering that may arise in the construction of works of this nature; in fine, the collection of material to make a complete map of that particular section of country, showing its extent and general topographical characters, with an accompanying memoir describing its physical features—such as the number and disposition of its inhabitants, its geological, botanical, and meteorological characters, and resources of every kind.

To proceed understandingly, let me first give a brief synopsis of the line for the proposed canal gleaned from the reports of those who profess to have already examined the route from ocean to ocean:

The grand and prominent feature of the proposed ship canal across the Isthmus of Darien, from the Atlantic to the Pacific, by the valley of the Atrato, is the connection of two oceans by an open cut without the aid of locks, therein differing from the several other routes which have been examined at different intervals.

Passing from the Caribbean sea into the Gulf of Darien you enter the Bay of Candelaria; the latter is represented to be three or four miles square, and of sufficient depth to allow the largest vessels to ride safely at anchor. Into this bay the Atrato, flowing almost in a northerly direction, empties itself by nine mouths. The entrance to these mouths are impeded by sand bars, covered with but few feet of water. It is proposed to widen and deepen one of them, the Coquito, by dredging, and, by breakwaters across the heads of the others, to force the whole mass of water of the river through it.

Ascending the Atrato, which is represented to be navigable for vessels of the largest class, the channel varying in width from two hundred and fifty to four hundred yards, the mouth of the Truandó, flowing in an easterly direction, is reached; the distance is said to be about sixty-five miles. You then follow up the Truandó to a point thirty-six miles above its mouth. This river is said to have an average depth of fourteen feet for that distance; a sufficient depth for the waterway of the canal to be obtained by dredging. At that point it is contemplated to commence an open cut of thirteen miles to the base of the summit of the Cordilleras, along the valleys of the Truandó, the Nercua, and the Hingador; then to tunnel through the rock base of the mountain summit, and extent of three and a quarter miles, and afterwards by an open cut of eight miles, following the valleys of several small streams to reach the Pacific Ocean: recourse must be had to that coast to either an artificial harbor or by making Humboldt's Bay available as the terminus. Thorough and complete surveys, with the most accurate and reliable instruments, can alone furnish the facts upon which to base the feasibility of executing a work, the grandeur and importance of which the whole civilized world must acknowledge—namely, the joining together, by a canal without locks, the waters of two immense oceans.

The question arises how is this to be accomplished in the most satisfactory way and in the shortest time.

The act of Congress calls for a joint commission of officers of the

rmy and Navy. Whoever may be selected for this important work, ıd whatever instructions may emanate from the honorable Secretaries the heads of the Army and Navy Departments, in reference to the ırts to be assigned to each, it should be the duty, as well as pleasure, each and every one, to devote his entire energy and abilities to the ork intrusted to him; and that, as the respective duties of each will so nicely intermingled, there should exist the most perfect coöpera-on and harmony.

Success can alone attend their united efforts. Inferring from the t authorizing the survey, that the honorable Secretary of the Navy ill furnish a vessel, with its complement of officers and men, to trans-rt the parties to the scene of their labors, I would respectfully suggest e following as the best plan, in my opinion, for carrying on the ork:

To proceed to the Bay of Candelaria, in the Gulf of Darien, and ere place a small party for the purpose of observing the hydrography that portion of the coast, the laws of tides, their rise and fall, the an tide level, and by as long a series of observations as are necessary obtain data for computing the cotidal hour and the establishment d altitude of the port; also to measure the velocity of the currents and within the bars of the principal mouths of the Atrato, to watch e effects of freshets, the highest and lowest stages of water, and to certain the quantity discharged by the river; also at the same time make a triangulation and survey of the mouths of the Atrato and y, including soundings for ascertaining the nature of the bottom; d, in short, all things pertaining to a hydrographic survey. A faith-meteorological record should be kept, the barometer to be read with treme care, that it may be used as a standard by which to compare barometric measurements; astronomical observations for longitude d latitude should also be made.

After suitable localities have been selected for these purposes, and oper precautionary measures taken to insure the protection and health the party, those left to discharge them the vessel should carry the in party to Aspinwall, and upon landing it to return to Candelaria y and there await the completion of the survey. Crossing by rail-d to Panama, the main party could either be transported thence to Humboldt's Bay," on the Pacific, by a government vessel—instruc-ns from the Navy Department having been had to that effect—or, by rchase, a small craft might be obtained to answer the same purpose. e reasons to be urged for commencing the principal work on the cific side are several, some of which I would respectfully suggest:

1st. The act of Congress confines the survey of the ship canal across Isthmus of Darien to a particular route by the Atrato and Truandó ers. In ascending the Atrato from the Atlantic side there would be ifficulty in finding the mouth of the Truandó, as so many streams represented emptying into the Atrato. This is not an imaginary ficulty, for those who profess to have made the previous examina-ns have, in conversation, urged this as an important consideration.

2d. The feasibility of this important work depends upon the exist-e of the depression of the Cordilleras and the selection of its lowest

point. To ascertain which, examinations should be instituted to discover whether there exists any deep defile or pass through it, and the necessary measurements of its height and breadth and extent should be made, to determine whether the importance of the work is commensurate with the immense labor, extended time, and enormous expense of its construction. The section from the Pacific to the Truandó is said not only to require the heaviest portion of labor, but the highest order of engineering. The preliminary examinations to decide upon the most practicable line could therefore best be made by passing the summit from the Pacific side, the distance to the summit being but a few miles from the ocean. Nor is it improbable that the line selected as the most advantageous may be more readily connected with the Atrato by some other stream than the Truandó.

3d. The terminus of a canal on the Pacific side should be definitely fixed upon, in order to connect the harbor by the most direct line with the cut or tunnel through the summit. During the examination of the coast by one party for selecting a harbor another could make the necessary reconnoissances for deciding upon the line to be definitely surveyed.

4th. The most trying and laborious part of the duty, is the survey from the Pacific to the Truandó, although this section is the most healthy, and less subject to rain storms. Would it not be better, therefore, to finish the most difficult part first, whilst all are in good health and spirits, and free from the exhaustion consequent upon labors along the feverish streams of a torrid zone?

The foregoing are a few of the many reasons which may be urged for commencing on the Pacific side.

The main party having arrived at Humboldt's Bay, the work should commence in good earnest. The same hydrographic and astronomical observations should be made, and geodetic work carried on, as at Candelaria Bay, corresponding observations being thus made at both places at the same time.

After reconnoitering the country, and deciding, by barometric measurements and careful examinations, the most practicable line, it should be first carefully marked out, and cut as short and direct as possible. In the second place, it should be carefully surveyed, so as to present it both in profile and plan. For this purpose a line of spirit levels must be run from ocean to ocean, in connection with which a continuous system of barometric observations would prove most interesting. Offsets ought also to be made to the main line at every 100 or 200 yards, or as often as the varying features of the country may require, each to be surveyed and leveled with the same accuracy as the main line, and all referred to the same plane of reference. All rivers and streams in the neighborhood of the lines, parallel to or crossing it, which can be made available as feeders in furnishing supplies of water, ought to be surveyed and connected by offsets with the main work. Their depth, breadth, velocity, and discharge at their lowest stage; the extent and duration of freshets; the nature of their beds and of the deposits formed; and all other features and phenomena should be observed, on which to form a practicable and definite judgment as to their character and resources.

A thorough hydrographic survey of the Truandó, above and below the point where the line of the canal may strike that river, has also to be made, and a like survey of the Atrato, from above the junction of the two rivers down to the Bay of Candelaria. Upon the data derived from these surveys and observations, facts founded upon perfect instrumental accuracy, depend the solution of most important engineering and geographical problems, all having a decided influence upon the practicability of an inter oceanic canal, without locks or other impediments to a free passage from ocean to ocean. Let me but glance at some few of the problems which may arise in the construction of such an open cut. Facts must be furnished before determining upon what is actually to be accomplished, but a few theoretical questions can be anticipated.

In the first place, the difference between the main levels of the two oceans has been found, by an accurate line of levels along the bed of the railway between Aspinwall and Panama, to be very little, if any. Colonel Totten says in his report, "Although my observations made the mean level of the Pacific from 0.14 to 0.75 feet higher than the mean level of the Atlantic, this is probably owing to local circumstances alone. We may, therefore, decide that there is no difference in the mean levels of the Atlantic and Pacific oceans."

The greatest difference between the high and low tidal marks on the Atlantic is ascertained to be not more than two feet; but for the Pacific it is said to be as much as thirteen feet. The question arises, presuming upon the practicability of a cut connecting the waters of the Truandó and the Pacific, what effect these tides would have upon the communication, whether or not the strong currents created by them would render navigation too dangerous and difficult; whether the summit level, at the junction of the Atrato and Truandó, is sufficiently high to prevent the flow of one ocean into the other during flood tides, or whether it may not lie too much so, and in that case create a too powerful current through the cut at the time of ebb tides; and lastly, to what extent this tidal action would be prejudicial to the Atrato.

In the second place, there is an interesting and important question to be examined, respecting the use that can be made of the Truandó towards the solution of the general problem—a grand idea has been conceived of by those who have already made examinations of this river, namely, the practicability of reversing its course, and making it subservient to the purpose of a river aqueduct for the Pacific section of the canal. This river is said to run through many large lagoons, into which numerous small tributaries empty. All of them could be made available as feeders.

Again, in the third place, the question arises whether the Atrato, which is fed by numerous large adjuncts, whilst at the same time it drains an immense valley, where it seldom ceases to rain, cannot also, from these sources alone, supply the necessary water for both sections of the canal, without reducing the level of its bed to any serious extent. The necessary works to produce this effect would be an interesting study for the engineer. To accomplish such an end without doing any material injury to the Atrato below its junction with the Truandó, is a problem which requires careful consideration. There is no branch in the

profession of engineering that offers greater difficulties and more uncertain issues, than the improvements and changes made in rivers.

In the fourth place, in the event of a mountain range being too high above the level of the ocean to make an open cut through it, would it be practicable to tunnel it? This is a question of time, labor, and money. In the last few years immense works of this nature have been finished, and many more are in progress of completion. Whatever be their extent, and the difficulties to be contended with, the science of engineering of the present day fears not the task. An affirmative reply to the practical question—"Will it pay?"—is only required to ensure success. Nothing is impracticable. But will the end be seen in the natural term of man's existence? Accurate measurements alone can demonstrate these problems. They are but a few of the most important matters to be taken into consideration.

The next question is, which is the preferable season for going into the field? There are but slight variations in temperature—the thermometer indicating nearly the same degree of heat all the year round. The mean temperature of the tropical regions, in consequence of the trade winds, sea breezes, and tropical rains, is lower than in some of the warmer portions of the temperate zone. The mean temperature on the coasts and islands of New Granada and the Isthmus of Darien, is often as low as 78° Fahr. for July; whereas the mean for the same month at Fort Yuma, on the Colorado, for three years, was over 92°, and for two successive years it exceeded 94°. The extreme heat will not, therefore, be a serious inconvenience, although the tropical rains may prove a great hinderance in conducting an instrumental survey.

From May to September, including both these months, is the season for perpetual rain in tropical regions. The precipitation during this period is very profuse; from that time until January it is comparatively dry. Heavy rains occur during parts of January and February, but abate very considerably during the remaining portion of the latter month, as well as in March and April. Perpetual rains are said to fall in the valley of the Atrato; but the Pacific side of the Cordilleras is dry for many months in the year. The season, then, for operating, according to the best information, would seem to be during the winter months; not leaving the United States until after the tropical storms have passed, about the first or middle of October. It is to be hoped that the survey will be completed in the course of one season, and the winter one will likely prove the most healthy. Leaving the United States in October, and returning the following April, the remainder of the year will probably suffice for the completion of the office work.

The following is a list of instruments which will be necessary for making a thorough and complete survey, viz:

1. Astronomical Instruments:

   One portable transit and stand.
   One zenith telescope and stand.
   One gambey sextant.
   One artificial horizon and trough.

Two wooden bottles of mercury.
Two sidereal box chronometers.
Two mean solar pocket chronometers.
One vial lacquer.
Six camel hair brushes.
Two small files and wire for stretching-wires.
Four cylindrical observing lanterns.
Two lamp-fillers and wicking.

2. Surveying Instruments:
Two theodolites and tripods.
Three surveyor's compasses.
Three fifty-feet chains.
Thirty-three marking pins.
Two schmalcalder compasses.
Four small pocket compasses.
Three engineer's levels.
Four mahogany level staves with targets.
One mason's level, two spirit levels.
Two reconnoitering glasses.
Four tape lines.
One standard brass yard measure.
Two ten-feet measuring rods.

3. Meteorological Instruments:
Four cistern barometers.
Two syphon barometers.
Six thermometers.
One standard thermometer.
One hygrometer.
One boiling point thermometer.
One wet and dry bulb and one maximum and minimum thermometer.
One case of bar magnets.
Magnetic deflecting and intensity instruments.
One dip circle.
Three rain gauges.
Extra barometer tubes.

4. Miscellaneous.
One box of drawing instruments.
Fifty sheets of protracting paper.
Two pairs steel rulers and triangles.
One box of chemical tests.
Four plumb bobs.
Two pairs of panniers, with connecting straps.
Two bottles of ether.
Two self-registering tide gauges.
Sounding poles and leads.
Stationery.

In order to economize the appropriation, many of these instruments can be furnished by the Topographical Bureau and Department of the Interior, with the consent of the Secretaries, by suitable requisitions; the period of time for which they will be required is brief, and if not detrimental to other services, might be employed in this work, and afterwards returned in good condition.

In regard to water transportation, the Navy officer connected with the expedition will no doubt be authorized by the honorable Secretary of the Navy to make such selection of a vessel and boats as are best adapted to reach the Isthmus of Darien, and to make the necessary river surveys. Lest the river currents may prove too strong, it would perhaps be advisable to take along a small steam engine, made to fit in one of the boats for the purpose of propelling it.

For land transportation six mules, at least, would be required, to be used as pack animals in carrying supplies and instruments forwards and backwards along the line. These can be purchased at Panama, and carried down the coast on ship board.

A sufficient allowance of camp and garrison equipage, and of arms and ammunition should be obtained; also provisions for at least six months. The quantities of each to be determined by the number of men to be employed by both Army and Navy officers.

To make a complete survey from ocean to ocean, the officer appointed by the War Department would require five assistants, namely: two officers of the topographical engineers, to have charge of some special, as well as any incidental duties that may arise; one carpenter; one geologist, botanist, and naturalist; and one draughtsman. Ten good men should be employed as instrument bearers, and for general service on surveys; and also some natives of the country, to be used as guides and packers, and for clearing away a line of survey.

It is recommended that the assistants, other than officers, be allowed $150 per month, and laborers two dollars per day, together with subsistence while absent from this country, and transportation to and from the scene of operations; and that the officers, while engaged in the field, be allowed a per diem, as commutation, in lieu of fuel and quarters, and to meet the increased expense of that section of country. It would be difficult to make a fair estimate of the expense of the whole survey without consultation on the part of the officers of both Army and Navy to learn what assistance can be obtained from their respective departments. The appropriation is a small one, and must be used judiciously.

Estimate for Lieutenant Michler's party.

The following estimate is based upon the supposition that the necessary instruments can be furnished by the Department of the Interior and the Topographical Bureau, and also that the Navy Department furnish the requisite boats for making the survey of the rivers, and the vessel to transport the parties to the Isthmus, namely:

Three assistants for one year, at $150 per month.............	$5,400 00
Two assistants for one year, at $125 per month...............	3,000 00
Ten men for six months, at $60 per month.....................	3,600 00

Four thousand rations, at 35 cents	$1,400 00
Four tents, conical and wall, at $50 per tent	200 00
Sixteen Colt's revolvers, at $25 each	400 00
Four shot guns, at $30 each	120 00
Six Sharpe's rifles, at $30 each	180 00
Six mules, at $100 each	600 00
Six pack saddles and blankets, at $12 each	72 00
Per diem for personal expenses for chief and assistants, and transportation of property	2,000 00
Three pairs leather panniers	90 00
Zoological department	300 00
Miscellaneous articles	438 00
Total	$17,800 00

Provided the War Department details another officer as assistant for this duty, and the arms and ammunition be furnished by the War or Navy Department, (the arms being required but for a short period,) the above estimate will be reduced $2,500, making the sum total $15,300.

From a conversation with Lieutenant Craven, of the Navy, who has received preparatory orders from the Navy Department for this work, I understand his estimate will not be more than two thirds of the above amount, or, say $10,000.

Lastly, it is respectfully suggested to the honorable Secretary that separate instructions, defining the relative duties of each of the officers forming the joint commission, be drawn up, so that there can be no possible misunderstanding between them; although it is to be hoped that none will arise, still, to insure success, it is better to leave no room for doubt. The work is of such great importance that the officers detailed to make the survey will only be too anxious to accomplish it successfully; the result will be looked for by the world with no slight degree of interest, and a lasting reputation is to be made for all engaged in the enterprise.

I am, sir, very respectfully, your obedient servant,

N. MICHLER,

Lieutenant Topographical Engineers, U. S. A.

Hon. ISAAC TOUCEY,

Secretary of the Navy.

NAVY DEPARTMENT, *September* 29, 1857.

GENTLEMEN: The tenth section of an act making appropriations for the naval service, approved March 3, 1857, having authorized the Secretaries of War and Navy, "under the direction of the President," to employ such officers of the Army and Navy as may be necessary for the purpose, "to make exploration and verification of the survey already made of a ship canal near the Isthmus of Darien, to con-

nect the waters of the Pacific and Atlantic by the Atrato and Truandó rivers," you have been selected for the execution of this duty.

The duty assigned you will call into exercise your utmost care and abilities, and it is expected that by a cordial coöperation the survey, in all of its details, will be thoroughly and successfully accomplished.

It is not deemed necessary to give you any other than general instructions as may be necessary for your guidance; the plan of operations will necessarily depend on such contingencies as cannot here be anticipated. On having made a preparatory reconnoissance, you will exercise your best judgment in so planning your work as to insure success, always keeping in view the requirements and instructions of the act of Congress, and so carefully examining the proposed route that not a doubt may remain as to its character. Let your report be full on the matter, embracing every requisite detail.

Should it be deemed advisable to commence the topographical survey on the Pacific side, the presentation of this letter will be sufficient authority to the commanding officer of any naval vessel that may be at Panama, to convey yourselves and party to Humboldt's Bay, or such other point as you may desire; provided, by so doing other more important duties will not be interfered with.

Should it be impracticable to afford you a passage, you are authorized to charter or purchase a bungo for the purpose, and any naval officer to whom you may apply for provisions or assistance, is hereby directed to furnish them.

Your attention is especially called to the preservation of the health of your party.

You will communicate to the department by every opportunity that may offer. Trusting that an undertaking which, if successful, promises such important results to the world, may be fully developed by your skill and energy, I am, respectfully, your obedient servant,

ISAAC TOUCEY.

Lieutenant T. A. Craven, U. S. N.,
Bound Brook, New Jersey, and
Lieutenant Nathaniel Michler,
U. S. Top'l Engineers, Washington, D. C.

Navy Department, *November* 6, 1858.

Sir: The department desires that you will submit to it at the earliest day practicable, the report, plans, and profiles of that portion of the survey of the Isthmus of Darien, of which you took notes and observations.

I am, respectfully, your obedient servant,

ISAAC TOUCEY.

First Lieutenant N. Michler,
U. S. Corps Top'l Engineers, Washington, D. C.

WAR DEPARTMENT,
Washington, November 8, 1858.

SIR: In regard to the position of Lieutenant Michler, of the Army, on the survey of a ship canal at the Isthmus of Darien, and his rank with Lieutenant Craven, of the Navy, I have to say that the question of the rank of officers of the Army with officers of the Navy is not settled by law or regulations.

Attempts to settle a relative rank between them have always been defeated by the respective services. Even when cases of conflict have occurred, the government has declined to decide, as between Commodore Stockton and General Kearney in California.

I cannot recommend an attempt to settle the question by executive orders. It seems to be better to leave it to the law. In the present case no decision is necessary. These officers were appointed to "co-operate together," as on a joint commission, and if they do not concur in a joint report, they should be directed to report to you severally.

Very respectfully, your obedient servant,

JOHN B. FLOYD,
Secretary of War.

Hon. ISAAC TOUCEY,
Secretary of the Navy.

NAVY DEPARTMENT, *May* 5, 1859.

SIR: As requested in your letter of the 5th ultimo, you are hereby relieved from duty under this department, and will report to the Secretary of War.

You will be pleased to return such instruments as you may have in your possession to the respective departments from which they were obtained.

I am, respectfully, your obedient servant,

ISAAC TOUCEY.

Lieutenant N. MICHLER,
United States Army, Washington, D. C.

WASHINGTON, D. C., *May* 6, 1859.

SIR: In compliance with instructions from the Navy Department, of which the following is an extract, I have the honor to report to the honorable Secretary of War.

NAVY DEPARTMENT, *May* 5, 1859.

SIR: As requested in your letter of the 5th ultimo, you are hereby

relieved from duty under this department, and will report to the Secretary of War.

* * * * * *

I am, respectfully, your obedient servant,

ISAAC TOUCEY.

Lieutenant N. MICHLER,
Washington, D. C.

Under the assignment by the War Department, through Special Orders No. 115, August 20, 1858, detailing me to assist in running and marking the boundary lines between the States of Maryland and Virginia, I shall prosecute this duty towards completion, and shall hold myself in readiness to comply with the further orders of the honorable Secretary of War, to resume, whenever the necessary funds may be furnished, the office duties connected with the survey of a route for an interoceanic ship canal near the Isthmus of Darien, *via* the Atrato and Truandó rivers, should it be contemplated by the honorable Secretary to present the results of my survey to Congress.

I am, sir, very respectfully, your obedient servant,

N. MICHLER,
First Lieutenant Top'l Engineers, U. S. A.

Colonel S. COOPER,
Adjutant General U. S. A.

II.

Importance of an interoceanic ship canal to connect the Atlantic and Pacific oceans.

In submitting to the public the perusal and consideration of the following pages, descriptive of the general topographical and physical features of the State of Chocó, in the republic of New Granada, so far as they have regard to the feasibility of connecting by a ship canal the waters of two immense oceans, together with the accompanying appendices, comprising the computations and results of the various instrumental measurements made during the survey of a route for that purpose, it would not be irrelevant to attempt a brief statement of the advantages and importance of this proposed magnificent work.

Let the map of the world be spread before the most unreflecting observer, and a single glance will be sufficient to convince him that the seeming intention of nature has been to so connect the two continents of the western hemisphere by a narrow isthmus in order that the energy and enterprise of the human race might remove the barrier between the two mighty waters, and achieve the success of what the Edinburgh Review is pleased to designate "the mightiest event in favor of the peaceful intercourse of nations which the physical circumstances of the globe present to the enterprise of man." Should the undertaking be ever successful, a complete revolution will be effected in the commercial relations of the world. "Incalculable as would be the advantages," so says the United States Magazine and Democratic Review, "in the present state of the commerce of the world, their benefit would be multiplied by the effect which such increased facilities of communication and exchange would exert to stimulate the immense masses of the human race thus acted upon to new efforts of industry in the development of the resources of the richest portion of the globe, which would vastly increase the amount of valuable production and the activity of commercial interchange above the present degree of either, and, finally, the moral influence upon all that section of the globe of bringing into such close and intimate communication with the civilization and institutions of the more favored countries of the north Atlantic will constitute a motive not inferior, to the eye of the philanthropist, to the aggregate of all the material advantages enumerated above." Let the opinion of the present distinguished head of the French nation, whose sagacity and wisdom are prophetic, be quoted; the emperor says that a ship canal across the Isthmus "would shorten, by three thousand miles, the distance which separates Europe from the western coast of America, as well as from Oceania, would render the communication with China, New Zealand, and New Holland rapid and easy by steam navigation; would raise immediately to a prodigious degree of prosperity the countries which such an enterprise would cause to be traversed every year by from two to three thousand merchant vessels; would open new routes for commerce and new marts to European produce; and, finally, would hasten by several centuries the march of Christianity and civilization

over half the globe." Opinions might be quoted *ad infinitum* to show the importance of a canal communication across the isthmus. The respective friends of each of the routes advocated all agree upon the necessity, although differing upon the best location for one. Some one or two more quotations will suffice. Several competent officers of the United States corps of engineers and topographical engineers have carefully examined the subject, and one, who has recently been engaged in examining the far West for the purpose of discovering a new route across the country to facilitate intercourse with the Pacific States, writes to a prominent journal that "to my mind, scarcely second to the project of a great national railroad across our continent looms up the important one of a ship canal through Central America. This, it strikes me, is the great political, commercial, financial, physico-scientific, moral and religious problem of the age, and, if it could be accomplished, would do more to civilize and christianize mankind than any and all projects taken together." One more authority may be mentioned who bore willing and constant testimony to the grandeur and importance of the great work to which he drew the attention of the civilized world more than fifty years ago; one who may be justly called the father of this noble scheme of improvement, as he well deserves the name among the savans of the day of being "the pioneer explorer of Central and South America." Alexander de Humboldt, whose death the world has been so recently called upon to mourn, "incessantly labored in the propagation of those geographical views which tend to prove the practicability of establishing commercial communications," and he lived long enough to be able to express the "deepest satisfaction" at the extensive surveys which had been made through that immediate section of country which appeared to him to be "the most favorable for the formation of canals of large dimensions." It would thus appear that the eyes not only of the United States, but those of all Europe, have been directed towards Central America for the solution of this most important problem. Notwithstanding the nearer route to the East Indies for European vessels would be through the Mediterranean, and then by a canal across the Isthmus of Suez to the Red Sea, still the preference seems to be awarded to the proposed route across the Isthmus of Darien. The frequency of hurricanes, which, at certain seasons, sweep over the Indian Ocean with frightful fury, not unfrequently damaging the finest ships whilst causing the loss of many, rendering the trip both dangerous and uncertain. Violent storms are seldom experienced in the Pacific, except in rounding Cape Horn. Ships are carried to the East Indies by the great trade wind without experiencing any bad weather. The immense work of piercing the Isthmus of Suez by a ship canal from Suez, at the head of the Red Sea, to the ancient port of Pelusium, on the Mediterranean, has, from the time of the Pharoahs down to the present day, occupied the attention of commercial nations. Within a few years practical examinations and operations have been going on to carry into execution this enterprise, the reports of the surveys and plans have been carefully examined and favorably reported upon, and nothing now remains but to give a practical solution to the problem. By this route some nine thousand miles

of navigation would be saved. An article published lately in the National Intelligencer says that the commercial men of Great Britain are much interested in a proposition to cut a ship canal across the Malagan Isthmus in India, so as to make shorter and safer the voyage to China. The canal would have to be cut only twelve miles to unite the bays of Bengal and Siam and save a voyage of one thousand one hundred and seventy-five miles through the Straits of Malacca and along a perilous coast. The completion of this canal and that across the Isthmus of Suez will place England within about the same sailing distance of China that New York will be by the way "of the ship canal across the Isthmus of Panama."

A great many explorations have been undertaken at different times, through various sections of Central America, to determine the most practical and economical locality for a ship canal; the routes through Tehuantepec, Honduras, Nicaragua, and Panama, have each been examined, and to all insurmountable objections seem to exist, either on account of the great obstacles thrown in the way by nature or the immense capital to be expended in the construction of canals of too many locks, to meet the demands of the commercial marine; distant communications require ships of great tonnage, which admit of being heavily laden. The "sad result of Lieutenant Strain's courageous expedition" from Caledonia Bay to the Gulf of San Miguel, insufficient as they were, demonstrated the impracticability of that particular line. For years Humboldt had called the attention of explorers to the Atrato and its tributaries, and from the pages of that most learned and experienced savan, a young and energetic gentleman of New York, Frederick M. Kelly, Esq., "began to study the scientific history and geographical outlines of Central America," and through that channel his thoughts were first directed to what he terms "the grandest project of this age of marvels," and one "which assumes to give to the commerce of the world a ship passage, without locks, through Central America, from the Atlantic to the Pacific ocean." Let a few pages from his most interesting pamphlet, styled "The Union of the Oceans by a Ship Canal without locks, *via* the Atrato Valley," be transferred to this chapter, in order to show his immediate connection with the examinations, for the future accomplishment of a great work, of the hitherto unexplored routes along the valley of the Atrato, from their incipient state up to the hour that he applied to his own government and induced it to organize a party to verify the accuracy of his labors to which he had devoted so much time, thought, and money; by this final act he desired to prove to the world the sincerity and honesty of his purposes, and to satisfy his own mind of the realization of a belief which had taken such strong hold upon his faith. In portraying his efforts, he writes as follows:

"Guided by the opinions of the illustrious Humboldt and of Admiral Fitz Roy, I sought, in 1852, for the proportions of a ship canal, by tracing the Atrato upward to its source, and by endeavoring to render its tributaries available by connecting them with the head waters of the San Juan, vainly hoping that a route for modern com-

merce might be found upon the line of the Jesuits' canoe communication.

"Baffled in this direction by the difficulties enumerated in the note below,* in 1853, I turned my attention to the rivers flowing through the left bank of the Atrato, between its headwaters and the Truandó. I left nothing untried in these directions, sparing neither expense nor scientific resources, but being baffled again, at the suggestion of Mr. Lane, I fell back upon the Truandó, convinced that there, or nowhere in the whole range of Central America, were the proportions of a ship canal to be found. This river was explored by Mr. Lane, as far as the Saltos, but, his health failing, he was compelled to return. I then fitted out another party, under Captain Kennish. Their instructions were to search for a good harbor on the Pacific, and, if possible, for a favorable place where, by a clear cut or a tunnel, that harbor might be connected with the Truandó and Atrato rivers, at such a level as to admit of nearly still water all the way, with depth and width sufficient to enable steamers, men of war, and merchant ships of heavy burden to pass from ocean to ocean without detention, and upon an even keel. Those only who have embarked their fortunes, time, and hopes of honorable distinction in great enterprises, can imagine the tremulous anxiety with which I waited for tidings from this party under Captain Kennish, which went out in 1854. Franklin was not more delighted when he drew the lightning from the clouds, or Columbus when he discovered America, than I was when it was demonstrated by instrumental measurements that the two oceans could be united; that all the science, industry, enlightened enterprise, and generous expenditure lavished upon this great field of investigation had not been exhausted in vain. Men of the highest intellect and moral elevation, such as Columbus and Humboldt, had foreseen the importance of this passage, sought and prayed for it. Cortez, Pizarro, and Balboa, as they pursued, across the isthmus and along the shores of both oceans, their schemes of discovery and of conquest, could scarcely believe that the great Creator had not somewhere provided a highway between the Atlantic and Pacific through that narrow thread of land which seemed hardly to divide them. From their day to ours, in all commercial countries, deep solicitude had been shown for the discovery of this passage. Men of science had searched for it, brave and energetic men had perished in those enterprises; governments and public companies had vied with each other in endeavoring to secure facilities for the annually increasing commerce of two mighty oceans, which the stern aspects of the Cordilleras had hitherto turned aside. How could I believe that the great Disposer of Events had crowned my humble labors with success? How could I fail to fear that my engineers might be

* "*Headwaters of the Atrato.*—Trautwine examined all the routes by the upper Atrato, by the Santa Monica, and the San Juan, by the rivers Pato, Baudo, and the Napipi. In 1853, Mr. Porter ran a line of levels over the Isthmus of San Pablo. The upper portion of the Atrato was again surveyed in 1853, by Mr. Lane. From the facts collected, all these routes were condemned. Communication in small vessels might have been established at great expense on some of them, or they may be hereafter turned to some account as transit routes, but one law excludes them all from consideration as great commercial routes: locks are required to make them practicable, and water to feed these, in sufficient quantities, is not to be found."

deceived?—that the resources of the scientific world might yet dispel the illusions to which, as though they were realities, I fondly clung? I went to England and submitted my plans and reports to the Royal Geographical Society of London and to the British Institution of Civil Engineers. I invited the searching criticism of those most competent to judge in the mother country. I went to France, and, knowing how deep an interest the Emperor Napoleon had taken in the promotion of similar enterprises, and how profound a knowledge he had displayed of the general subject at a time when correct views were confined to a very limited circle, I laid my plans and surveys before his imperial majesty, and invited to their consideration, in the most public manner, the highest science in the service of the government and people of France. I went to Berlin, and frankly explained to that illustrious sage, the pioneer of all scientific knowledge of Central America, the general views which I entertained, and the nature of the evidence by which they had been confirmed. In those three enlightened countries I was not treated as a stranger. There was a grandeur in the design of which I was the bearer, a dignity in the mission with which I was charged, that won for me the courtesies which, on mere personal grounds, no stranger going to Europe for the first time could have anticipated or claimed. From the Emperor of the French, from Lord Clarendon, from Sir Roderick Murchison, from Baron Humboldt, from Rear Admiral Beechy, from Robert Stephenson, from Admiral FitzRoy, and the members generally of the Royal Society and Institute, I received great kindness; and, what was of more importance, they applied to my plans and reports in a catholic and courteous spirit, but with the rigid exactness due to science and their own high reputations, those tests suggested and fortified by their great experience. A friendless and unknown American citizen was treated by these men as though he was a brother, not because he was eminent in science, but because they recognized in him the zeal, the prophetic hope and self reliance, which are ever the handmaids of science.

"While the honest criticisms or kind consideration of those elevated and enlightened men strengthened and encouraged me, I felt that they laid upon me a new obligation. I was bound to give to them, even more than to the world at large, the best evidence of the sincerity and honesty of my purposes, and of the skill and integrity of the agents I had employed. I could only furnish this evidence by the aid and through the instrumentality of the government of my own country. The Hon. James Buchanan was then our minister to England. That distinguished man not only discharged toward me the duties of hospitality and courtesy, to which, perhaps, as an American citizen I was entitled, but he encouraged me to hope and to apply for the verification of my own government; and one of his first acts, when the suffrages of the nation had placed him at its head, was to facilitate the passage of a law under which that verification has been obtained.

"To secure, upon the authority of officers pledged by their reputations, no less than by the obligations of their official positions, to accuracy and good faith, a confirmation of my views, and of the accuracy of my engineers, was the last and highest duty which I owed to the scientific world, to the engineers who had aided and advised me, and to those

friends who, in Europe and America, had shown me countenance and given me support."

That duty has been discharged. The Congress of the United States, realizing the importance of the enterprise, and stimulated to take the lead in prosecuting the necessary explorations, passed an act, which was approved March 3, 1857, by President Buchanan, making an appropriation for that purpose. Section 10 of that act reads as follows:

"*And be it further enacted*, That the Secretaries of War and Navy be authorized, under the direction of the President, to employ such officers of the Army and Navy as may be necessary for the purpose to make exploration and verification of the surveys already made of a ship canal, near the Isthmus of Darien, to connect the waters of the Pacific and Atlantic by the Atrato and Truandó rivers: *Provided*, That the expense shall not exceed twenty-five thousand dollars, which are hereby appropriated therefor out of any money in the treasury not otherwise appropriated."

In accordance with this act, orders and instructions were issued by the War and Navy Departments, each detailing an officer for the important service. Copies of said papers and of the plan of operation proposed by the officer of topographical engineers, together with additional documents, subsequently issued by the same authorities, in relation to the official duties and positions of the two officers directed to coöperate during the survey, form prefix to this report. The latter is made in accordance with instructions directing the officer of topographical engineers to submit the report, plans, and profiles of that portion of the survey of the Isthmus of Darien, of which he took notes and observations; that officer having had sole and direct charge of the topographical survey between the Gulf of Darien and the Pacific ocean, by the proposed ship-canal route, the results and maps are herewith appended and submitted by him for the consideration of those interested in the solution of the great problem of the age.

The direction of the survey "having been placed under the general control of the Secretary of the Navy," he states in his instructions to the officers that "the duty assigned you (them) will call into exercise your utmost care and abilities, and it is expected that, by a cordial coöperation, the survey in all its details will be thoroughly and successfully accomplished. It is not deemed necessary to give you any other than such general instructions as may be deemed necessary for your guidance; the plan of operations will necessarily depend on such contingencies as cannot here be anticipated." He further adds, that "you will exercise your judgment in so planning your work as to insure success, always keeping in view the requirements of Congress, and so *carefully examining the proposed route* that not a doubt may remain as to its character. *Let your report be full on the matter, embracing every requisite detail.*"

At his request the Secretary of State took the necessary steps to obtain the consent of the New Granadian government to their labors, addressing an official note to General Herran, envoy extraordinary and minister plenipotentiary of that republic, stating the circumstances, and asking that he would communicate on the subject with his government. General Herran immediately acknowledged the receipt of the note of

General Cass, "desiring that the proper communications should be made in order that the officers detailed by the government of the United States to explore the Isthmus of Darien may find no obstacle in performing their mission; and together with the note came passports issued for the two officers, and a copy of the note of the Navy Department." He replied that "this legation will ask from the government of New Granada, by the next packet, the issuing of the proper orders, so that the authorities of the republic afford all the facilities in their power for the success of the proposed expedition. Meanwhile these orders are coming from Bogotá to the State of Panama and to the province of Chocó, the undersigned makes use of the authority he holds to offer to the government of the United States, in the name of New Granada, the permission to make the exploration, and every coöperation in the State of Panama as well as on the Isthmus of Darien that the authorities of the country can give. For that purpose I have the honor to inclose a note for the governor of the State of Panama, and a recommendation to any officers or citizens in all the territory which the commission may visit, and I return the two passports properly visèd. The policy that New Granada has adopted in regard to the points of its territory where interoceanic communications may be opened is to throw them open in order that there may be made as many explorations and studies as may facilitate the construction of the communications, with the view that all nations may use those which may be constructed. The exploration about to be undertaken under the auspices of the government of the United States will give great satisfaction in New Granada." General Herran in the name of his government proceeds to assure General Cass of this, adding that the legation "is always ready to coöperate in every possible way to carry out the *great idea* of the United States." In the annual report of the Secretary of the Navy of 1857 to the President, shortly after the sailing of the expedition, he says in referring to the act of Congress making an appropriation for the survey, that "when we consider the magnitude of the object, the influence it is destined to have upon commerce, if accomplished, its effects in binding together in closer relations the remotest parts of our Confederacy, we cannot fail to regard any hopeful enterprise having this object in view as fraught with the deepest interest. It is not without hope, founded upon reliable information, that this enterprise is undertaken."

In conducting the late explorations and surveys the officer in charge of the topographical party endeavored to use greater precision and accuracy in its various details than has hitherto been the case in preliminary reconnoissances of the same nature, especially as the problem under consideration is one whose successful demonstration depends principally, and more particularly so than any other, on the choice of locations. Although this was the case, it would be far from wise to begin on the line surveyed without having examined and leveled others in the immediate vicinity; and the proof would be the more satisfactory after having thoroughly studied and compared the results obtained, and the advantages claimed for the particular one in question with those of the several other routes that have been urged upon the public. It will be seen that the writer of this has studiously avoided making any gratu-

itous comparisons between the separate and distinct routes located in Tehuantepec, Honduras, Nicaragua, Panama, and those leading from the valley of the Atrato. He will endeavor to present the impressions made upon his mind at the time, and to give a true and impartial description of the one which became his particular province to examine. He will also furnish in the appendix copies of the original notes of the instrumental surveys in the field, together with the computed results, and respectfully challenges the most scrutinizing investigation as to their correctness. In the language of Humboldt, "such is the happy position of these five points that they are placed at the center of the new continent, at an equal distance from Cape Horn and the northwest coast. Opposed to each (in the same parallel) are the seas of China and India, an important circumstance in latitudes where the trade winds prevail. All are easily entered by vessels coming from Europe and the United States." Let, therefore, a strict comparison be made between the relative merits of each, not by speculative and interested parties, but by the best engineering talent of the world. The idea of locating any particular line through the section of country examined for an interoceanic canal has not been allowed to enter the mind of the officer in charge of the topographical party. Naturally interested in the feasibility of a work upon which he has been engaged, where reputation as well as obligation to his official position require perfect accuracy and good faith, his hopes and labors have been solely directed towards collecting the necessary data, also in arranging and compiling them, in order to obtain some demonstration of the practicability and probable cost of so magnificent an undertaking, one fraught with such vast importance to mankind.

III.

CHAPTER DESCRIPTIVE OF THE NATURAL FEATURES OF THE COUNTRY ALONG THE LINE OF SURVEY OF THE PROPOSED INTEROCEANIC SHIP CANAL, ETC., FROM THE GULF OF DARIEN TO THE PACIFIC OCEAN, VIA THE ATRATO AND TRUANDÓ RIVERS.

Province of Chocó—State of Cauca—Republic of New Granada—South America—Chapter descriptive of the natural features of the country along the line of survey of the proposed Interoceanic Ship Canal from the Gulf of Darien, or Urāba, to the Pacific ocean, lying between the seventh and eighth parallels of north latitude—The ascent of the rivers Atrato, Truandó, Nercua, and Hingador, the crossing of the Cordilleras de los Andes, and the descent of the Pie de Nercua and Totumia, to the Estero de Paracuchichí, (Bahia Ensenada, or Kelley's Inlet.)

From Humboldt's "Views of Nature" we read that "the impression which is left on the mind by the aspect of natural scenery is less determined by the peculiar character of the region than by the varied nature of the light through which we view, or mountain or plain, sometimes beaming beneath the azure sky, sometimes enveloped in the gloom of lowering clouds. Thus, two descriptions of nature affect us more or less powerfully in proportion as they harmonize with the conditions of our own feelings, for the physical world is reflected with truth and animation on the inner susceptible world of the mind. Whatever marks the character of a landscape; the profile of mountains which, in the far and hazy distance, bound the horizon; the deep gloom of pine forests; the mountain torrent which rushes headlong to its fall through overhanging cliffs—all stand alike in an ancient mysterious communion with the spiritual life of man.

"From this communion arises the nobler portion of the enjoyment which nature affords. Nowhere does she more deeply impress us with a sense of her greatness—nowhere does she speak to us more forcibly, than in the tropical world, beneath the 'Indian sky,' as the climate of the torrid zone was called in the early period of the Middle Ages."

Induced by these views to consider most attentively the nature of the task imposed, and the success of its accomplishment, one readily becomes aware of the difficulty of the attempt to present a true portraiture of the richly-endowed regions, near the Isthmus of Darien, recently traversed by those engaged in the execution of a most interesting and important duty—the survey of a route for an Interoceanic Ship Canal. Words cannot convey to the many who have never gazed upon similar scenery, the varied emotions there experienced with every change of physical features. Still, while the effort may prove vain and futile, one may nevertheless encourage the hope "that the peculiar charm which belongs to them may not be unfelt;" but, on the contrary, aid in relieving with delicate touches the poor efforts made to delineate them.

On the part of every member of the expedition, longing desire to face the fate of that new and uncertain future which lay hidden among the luring and deceptive paths of a most gorgeous tropical world, and around which hung the many dangers of which the fears of friends at home were so prophetic, this feeling had not contributed much toward allaying the anxious suspense created by the many weeks of tedious detention and confinement on board of a small schooner which bore away from the harbor of New York those sent forth by the United States government to execute a mission replete with interest to the commercial world. During the sea voyage a call was made at the walled city of Cartajena, the key to the republic of New Granada. A delightful sojourn there for a short time furnished some most pleasing remembrances, which form a beautiful episode in contrast with other periods of a most venturesome expedition.

GULF OF DARIEN OR URABÁ.

Early on the morning of the first day of December, 1857, there appeared in the dim distance the first glimmering outlines of the headlands of the Gulf of Urabá or Darien.

Cape Tiburon on the west, and Cerro de Aguila on the east, guard the entrances. A large expanse of water, varying from six to twelve miles in width, sets inland from the Caribbean sea for thirty-five or forty miles. For some distance on the west it washes a bold and well defined coast, whilst on the east, spurs from the Antioquian chain of the Cordilleras stretch toward though not touching it, broad plains intervening. On the opposite land, the blue contour of the main Cordilleras confines the limit of vision. Between this and the Antioquian chain, extending far away towards the south, lies the immense valley of the broad, deep, and magnificent Atrato, with its several tributaries. A favorable wind from the north bore the schooner Varina onward in her course, and towards evening the low flat lands of the Delta of the Atrato became visible on her right, and soon after, those bordering the river Turbo on her left. A few minutes before sunset she hove to and anchored in the gulf, a mile from the little village of Turbo or Pisisí, and several from the bocas or mouths of the Atrato, on the opposite shore.

Besides the waters of the Atrato, debouched through its thirteen bocas, the gulf is also the recipient of other streams, none save the Leon of any very large dimensions. Starting from the former, and following around towards the south and east, they are named in the order of succession, Zuriquillo, Leon, Micura, Karacuarando, Guadalito, Turbo, Copé, Cirilo, Caimàn, Nuevo, Caimàn Viejo, Urabá, and Ycoquillo, most of them small and insignificant streams. A visit was made to the Rio Turbo. It was found to be narrow, tortuous, and sluggish: one of those rivers of death, so calm and tranquil, and ever dissipating fumes of deadliest malaria, while its banks are fringed with the gorgeousness of the richest tropical vegetation, and the air perfumed with the sweet scent of bright flowers. Its quiet stillness is only disturbed by the warbling of beautiful plumaged birds, the hiss of the deadliest serpent, the growl of the fierce tiger, or the sudden

plunge of the timid alligator. An attempt to force a path for a few feet from the banks of the stream into the dense forest bordering it, in search of rare plants and flowers and birds, proved how impenetrable are these primeval forests. Climbing vines, interlaced and matted together, constantly impeded the progress of any forward steps. A strong arm and a sharp machete alone can extricate one from these ever recurrent obstacles. A cool head is also an indispensable requisite, lest, in a moment of doubt, one may be lost in the depths of a forest exclusively tropical, and whose denseness surpasses anything known in the temperate zones.

There is no uniformity of vegetation. "The excessive variety of their rich sylvan flora renders it vain to ask of what do the primeval forests consist. Numberless families of plants are here crowded together, and even in small places plants of the same species are rarely associated." The vegetation along the coast was also profuse, reaching to the water's edge, and hung with graceful festoons of clinging vines, their foliage ever varying in hue and character. The two varieties of palm, called by the natives Pangana and Murapo, were most numerous, and by their beautiful and graceful forms, charmed the senses, rendering the scenic effect rich and superb. These woods are the haunts of different species of the feline race, whilst nearer the base of the mountains the deer and the pecary abound.

With the ornamental were mingled the useful plants. Plantain and banana fields extend along the Turbo; sugar cane and rice grow; the cocoa, from which the finest chocolate is manufactured, and the cocoa palm, the milk of the nut most refreshing, and its pulp tender and palatable, also flourish. Besides these, there are many other fruits and nuts peculiar to the tropics. Whilst the province of Chocó luxuriates in the fulness of its harvests, other portions of the republic of New Granada, a country so rich in soil, and possessed of such varied climatic features, furnish to distant marts many valuable productions of the vegetable kingdom; many of them in such proportions as to be able to meet the present demands of the civilized world. Besides the different cereals, there are indigo, tobacco, sugar, cotton, coffee, cacao, and the finest qualities of cincona, together with the balsam, ipecacuanha, and many other medicinal plants, all of which are to be found either along the tierras calientes of the coast, or on the more temperate plains and table lands of the mountainous sections of the country.

The Gulf of Darien, in the neighborhood of the more southern mouths of the Atrato, offers a secure anchorage at all seasons of the year. The holding ground is composed of a mixture of mud and sand, samples having been brought home for examination. During the winter, the north winds blow fresh from the seaward, but their strength is much diminished by the islands intervening in that direction. Even in the highest winds experienced during the presence of the Varina, open boats crossed safely over the gulf, and bungos (the ordinary river and trading boats of the country) lay quietly at anchor in the most exposed positions.

The gulf itself abounds in many varieties of fish, and in the tortoise. The former are caught, dried, and packed for market, and the shells

of the latter sent to Cartajena, and there manufactured into beautiful combs and card baskets.

SETTLEMENTS—INDIANS.

The republic of New Granada is divided into several States, and these again subdivided into provinces. One of the latter, drained by the Atrato and its tributaries, bears the name of Chocó. The village of Turbo, or Pisisí, is now the only place inhabited along the gulf. According to Irving and other histories of the early adventures of the Spaniards, a settlement called Santa del Antiqua had been founded many years ago, near the mouths of the Atrato. The French are said to have also established themselves near the Tarena mouth, for the purpose of trading with the San Blas Indians; but no marks now remain to indicate the original sites of their localities. The walls of an old deserted town on the banks of the Urabá river, still stand as a memento of the idomitable energy and will of the old Spanish race. A small tribe of Indians, called Caimanes, (or Alligators,) are the sole occupants of the territory between Punta Arenas and Turbo, and are said to be very inoffensive. The Chocó Indians live on the Leon and the different tributaries of the Atrato, but as they are often met with in course of the journeyings made along the latter, it will not be necessary to speak of them at this time. The nearest settlement of the San Blas Indians is about two days' travel from Turbo. After leaving the Atrato, several ciénegas and lagunas near the coast are passed before reaching their villages. This is a very independent tribe, and although friendly to foreigners visiting the coast, and perfectly willing to trade, still threaten to resist any attempts made to explore their province. They see the result of the old Spanish rule in the degradation of the neighboring tribes, and will not submit to be conquered. Their appearance is not at all remarkable, being small in stature, like all South American Indians. A party of them visited Turbo, and desired to know if the Americans intended again to attempt a passage through their country, for rumors to that effect had reached them. In such an event, they threatened to resist all encroachments to the last. They are well to do in the world, industrious and laborious, and their country is said to be rich in mineral wealth.

STRAIN—PREVOST—CULLEN.

The desperate character of that most ill-fated expedition under charge of the late Lieutenant Isaac C. Strain, of the United States Navy, from Escoces or Caledonia Bay across to and down the Chuquanaqua to the Pacific, was, to a great extent, a consequence of the hostile disposition of the San Blas Indians. Prevost, of the English Navy, suffered not a little in the loss of men from the same cause, whilst endeavoring to cross from the Gulf of San Miguel to the Atlantic. If a diversion may be here allowed, let me quote a few lines from the report of the former to the Secretary of the Navy, in regard to the route he pursued; says the report: "This, sir, terminates the narrative of the United States expedition to the Isthmus of Darien, an expedition with-

out brilliancy because without success, and whose reputation depends in a high degree upon the fact that it has only disproved a magnificently preconceived theory" in regard to the practicability of building an interoceanic ship canal. The termination of the report of Prevost reads as follows: "So toilsome was our journey that we spent fifteen days in performing a distance of little more than twenty-six miles, having to force our slow and laborious path through forests that seemed to stretch from the Pacific to the Atlantic shores. The trees of stupendous size were matted with creepers and parasitical vines, which hung in festoons from tree to tree, forming an almost impenetrable network, and obliging us to hew open a passage with our axes every step we advanced."

He also writes, that "although finding ourselves in the center of the Cordilleras, and, I believe, within a very few miles of the object of our search, yet, having already exceeded the limit of my stay, it became my duty to rejoin the ship without delay; still feeling confident that had time and our provisions allowed us, we should have eventually reached the Atlantic shores, and that easily, by following one of the several rivers or streams which appear to exist in this range of the hills, forming certain passages to the sea."

The little information obtained by either of these expeditions is still sufficient, however, to prove the utter impracticability of the route examined for a ship canal from Caledonia Bay to the Gulf of San Miguel, notwithstanding the assertions of Dr. Cullen and others to the contrary. Dr. Cullen professes to have crossed and recrossed the same line, and found it perfectly feasible; he, therefore, does not hesitate to apply to these examinations, previously set on foot by the United States and England, the not very flattering encomium of "ill-fated and mismanaged Darien expeditions."

TURBO OR PISISÍ.

The village of Turbo or Pisisí, the former the Spanish name and the latter the Indian one, so called after the cry of one of the birds infesting that locality, is situated near the mouth of a turbid stream, and extends along the shores of a small harbor of the same name. The latter is but a slight indentation of the coast protected by a point of land called Sand Point, which projects some little distance out into the gulf; this neck not only breaks the force of the waves, but the dense timber upon it baffles the strength of the north winds, rendering the haven a safe and commodious one for the river boats plying between Cartajena and points along the Atrato. The settlement contains but a few houses, and in the fall of 1857 numbered about two hundred and thirty inhabitants, of every age and sex. With the exception of Mr. Dean, an Englishman by birth, but for many years a resident of New Granada, they are principally of Spanish origin or negroes. Their chief occupation consists in collecting caoutchouc, and for that purpose the men are scattered far and wide along the streams flowing into the gulf; about eighty tons per year are collected and brought to Turbo, thence shipped to Cartajena to be prepared, cleaned, and pressed for the New York market. The houses are built upon

piles of palm wood, the first floor about three feet above the ground; the sides are formed of bambo canes, placed vertically and closely tied together; the roof is thatched with the leaves of the palm, or with a coarse grass found growing near the mouths of the Atrato; the flooring consists of the exterior bark of some one of the varieties of palm, the rafters and beams being of the same wood; strings are furnished by the wood of the chonta duro, a species of Martinezia, which answers the purpose admirably. The village lies on a low, wet peninsula; its level about two feet above high-water mark. The floors are raised for the double purpose of being removed above the damp soil, as the ground is entirely submerged during the rainy seasons, and also to prevent the unwelcome visits of various reptiles, as well as the intrusion of their domestic animals when seeking protection from pending storms. Ditches are dug, and to some extent drain the village. A remarkable tree is to be seen near by, called by the natives the Lano (or wool) tree; a portion of the roots is exposed for some ten or twelve feet above the ground, covering a circular space of at least twenty feet in diameter; the lower extremity of the trunk is six feet in diameter, and rises to a great height. The bark is often punctured by insects, and on the wood seeds of various plants—either wafted through the air or dropped from the beaks of birds in their flight—find resting places wherein to germinate; the tree then presents the singular appearance of giving growth to several varieties of leaves and flowers; a few species of cacti, besides many other parasitical plants, had taken root in the Lano tree and exhibited to several stages of climatic change, from extreme moisture near the ground to the dryer strata of air encompassing its upmost branches.

ATMOSPHERE—TEMPERATURE—RAIN.

Several days were passed in the gulf in attending to certain duties, and in making various arrangements preparatory to the ascent of the Atrato. The days and nights during this time were beautifully bright; in but few climes can the gaze rest upon the distant splendor of more perfectly glittering star-light skies. Often during the evening sad glances scanned the bright expanse of heaven for that old friend of a northern home, the north star, steadily shining in its place but a few degrees above the horizon; and early in the morning the awakened eye would turn in admiration towards the beautiful constellation of the cross, the bright cross of the South, and behold it shine away where "the far Cordilleras unite with the sky." When deep midnight threw the pall of darkness over slumbering earth, the bright belt of Orion and fiery Sirius, and the planets Jupiter and Saturn, held their places high in the zenith. At early dawn, Venus, the morning star of the East, resplendant with beauty, welcomed in the approaching day, only to shine for a period ere mingling its soft light with the fiery glare of the rising sun. The weather was usually clear. During the brief stay in the gulf, it rained only once by day, though very slightly, and but once for a few moments after dark. So far from being the horrible climate represented by others, one of continuous storms, excessive heat, and miasmatic atmosphere, the veritable Pandora's box

of all the malaria of the most feverish portions of the world, the atmosphere proved to be extremely delicious. It so continued during the entire stay of the Varina in the Gulf, from the first of December to the latter part of March, with the exception of two nights previous to weighing anchor, homeward bound. As if not to let her depart without a benefit, heavy rains, such as are only known in the tropics, fell for hours upon her decks, attended by most terrific peals of thunder. The play of lightning was so quick and intense as to vivify all surrounding nature. According to the most reliable information the rainy season along the Gulf extends from early in April to the latter part of November. The "rains are not, however, by any means excessive even during this period, but occur chiefly in the shape of short, smart showers of from a few minutes to some hours duration, especially during the night, with occasional heavy and prolonged falls of one or two days. It is even by no means uncommon for intervals of from three to six days to elapse during the wet season without a day of rain. Subsequent experience of some months along the valley of the Atrato and San Juan proved that by far the greater portion of the rain of that region falls during the night."*

There are but slight variations in temperature, the thermometer indicating nearly the same degree of heat during the entire year. The mean temperature of the tropical regions, in consequence of the trade winds, sea breezes, and copious rains, is lower than in some of the warmer portions of the temperate zones. The mean temperature on the coasts and islands of New Granada and the Isthmus of Darien is as low as 78° Fahrenheit in July, whereas the mean for the same month at Fort Yuma, on the Colorado of the West, during three successive years was over 92°, and for two successive years it exceeded 94°. The extreme heat is not, therefore, a serious inconvenience to the performance of any manual labor.

CORDILLERAS DE LOS ANDES.

By a glance at the geographical position of the mountains of the republic of New Granada, as represented on the more recent maps of South America, it may be seen that the main Cordilleras de los Andes, after crossing the line of the equator and stretching out toward the northern portion of the province of Chocó and the southern extremity of the Isthmus of Darien, separates into three distinct chains. The first branches off near the second parallel of north latitude, from the main trunk towards the northeast, and is bifurcated between the fourth and fifth parallels. The two beautiful and wealthy valleys which longitudinally separate these chains are drained by the Rio Magdalena and the Cauca. The Antioquian, or the western chain, gradually becoming lower and lower, extends in a north direction towards the Gulf of Darien and the Caribbean sea, breaking up into numerous spurs. Many of the intervening valleys form basins for the tributaries of the Atrato, whilst one of the largest is coursed throughout by the Leon. This last river, as before mentioned, empties into

*See Notes on the Atrato, by Trautwine.

the gulf; its head waters are within two days walk by the natives, about twenty miles of Antioquia; it is said to be navigable for its whole length by steamers, the only improvement necessary being the removal of some overhanging limbs of trees. The province of Antioquia is very rich and fertile. The Antioquian chain not only separates the valley of the Rio Cauca from that of the Atrato, which winds its long way towards the Atlantic, but one of its spurs also forms the divide between the latter and San Juan, flowing into the Pacific. The waters of the two last are said to have been united by the Raspadura canal, built under the direction of the Cura of Novita, in 1788, for canal navigation, in order to transport various productions from one coast to the other. There is a doubt whether such a work was ever executed, or, more likely, the accounts in relation to it are very much exaggerated; however, at the present time no traces remain in proof of its previous existence. The height of the ridge between the headwaters of these two rivers above the mean level of the sea has not been published, but different engineers who have surveyed the route pronounce it impracticable for a ship canal, even for one of very small dimensions.

From the head of the San Juan and west of the upper tributaries of the Atrato, a low chain of mountains continues to run, very nearly parallel to the Pacific, and not far distant from its shores. By their geographical position they may be considered as a connecting link between the Cordilleras de los Andes, of South America, and the Rocky Mountains, of North America. The ridge dividing the two oceans becomes already quite low upon nearing the heads of these rivers, but as one proceeds through the northern part of Chocó, the mountains are found to be more and more depressed. Upon looking towards them from the Pacific coast, they in reality then appear to the eye to have entirely disappeared. There is undoubtedly a great depression, as the accurate geodetic survey with spirit levels made by the engineer party of the late expedition has proved, but as to there being "no chain of mountains, not even a ridge of partition, or any visible demarcation" between certain points on the Pacific and some of the tributaries of the Atrato, many writers either have erred in the general inferences drawn by them, or have been very much misinformed. Captain Cochrane, who professes to have crossed from the Cupica Bay to the Atrato, reports that there "the chain of the Andes is entirely broken off, and sinks first into hills and then into a level plain." Berghaus says that, "as the mountains approach the Isthmus of Darien, they gradually sink down towards the coast of the Pacific into a level plain," and that "there is hardly a single ridge or elevation to be found on the plains to the west of the lower Atrato." These extracts, and many others which might be given, show the absence of correct information in reference to this interesting section of the world. An extremely dense tree vegetation conceals the outlines of the hills, and from a distance, owing to their slight elevation above the level of the ocean, and no marked profile being visible, the appearance of an extended plain is presented to the spectator, and as the heights are approached, the rise is so gradual from the sea inland, that the senses can be very easily deceived as to their elevation. This was the case

even with certain members of the late expedition, who actually passed over the entire ground. Some of these, however, either by the visual organs having proved somewhat blinded, or their mental ones being greatly biased, have been so presumptuous as to endeavor to overshadow the true state of the case by offering to the public their own guessed estimates of the heights of mountains, thereby giving them a preference to those determined by exact instrumental surveys. Such a person has not only an illusive eye, but a delusive imagination, if he thinks his assertions can be credited. As you near the southern extremity of the Isthmus of Darien or Panama, the Cordilleras "break into detached mountains of considerable height, and of the most abrupt and rugged formation," their distant blue outlines exhibit those magnificent views seen from the Gulf of Darien, or when approaching the coast from the sea.

THE ATRATO RIVER.

Between the western slope of the Antioquian chain and the eastern one of the main Cordilleras, lies the immense valley of the Atrato. The tributaries of the latter are quite numerous, and some few of very considerable dimensions. Those springing from the first range wash down "golden sands" of great purity and richness into the valley below, which are collected in order to add their slight increase to the world's affluence; while those draining the second fill a more important mission. These last guide and lead along their meandering courses important researches, with the view of uniting the waters of the two great oceans by a ship canal, through which the commercial marine of the world may carry untold millions of wealth; a grand and noble undertaking; a project most devoutly and religiously to be prayed for.

A strong hope is encouraged that one of these tributaries, the Truandó, has at last led the way towards a successful solution of the problem. It is believed, and with strong reasons to encourage the belief, that a route has at length been discovered, by which the hitherto impenetrable barriers presented by the Cordilleras may be successfully removed or overcome, and a work so pregnant with great results to civilization be successfully accomplished. The valley of the Atrato lies between the parallels of 5° 26′ and 8° 5′ north latitude. It varies in width from 100 to 150 miles, and covers an area of 21,000 square miles of alluvial soil. The spacious bed of the river, broad and deep for a long distance above its mouth, drains an immense extent of country, and is estimated to be from 250 to 300 miles in length. It is the receptacle not only of the torrent streams borne down from the mountain slopes, but of those copious tropical rains which fall in broad sheets of water over the adjoining marshes. How black and gloomy the lowering clouds then become; they cover the whole surrounding country with almost impenetrable darkness, leaning, as it were, upon the very earth for support in their great heaviness.

From the mouth of one of its tributaries, the Truandó, down to the Gulf of Darien, along that portion which came more especially under

the observation of the last government expedition, the Atrato is truly a most noble and magnificent river.

In addition to the name of Atrato, the river has also been known by those of Rio Grande del Darien, Rio del Chocó, or Rio Dabeiba. The name Dabeiba is that of a female warrior, who reigned, according to the first historian of the conquest, in the mountainous countries between the Atrato and the source of the Rio Sinu, on the north of the town of Antioquia. According to the work of Petrus Martyr d'Anghiera, this woman was confounded in a local mythology with a divinity of the lofty mountains, "whence dart the lightnings." After coursing along for many miles through a rich alluvial soil, the Atrato debouches into the Gulf of Darien through thirteen caños, or arms, or branches, alike in nature, but varying in length, breadth, and depth. They are severally named, in order of succession, from the north, as follows: Tarena, Candelaria, Pavas, Barbacoas, Coquito, Coco Grande, Pantana, Pedrito, Pedro, Urabá, Urabacito, Pichindí, and Pichindicito. The mouths, or points of engulfment, are called by the natives *bocas*. These caños do not, each and all, depart directly from the main stream, but the larger ones, after separation from it, are again subdivided into others. For a more comprehensive understanding, let the main body of the river be reached through the Caño Coquito—the one usually taken by the river boats entering or leaving the Atrato. A neck of land jets out into the gulf, through which the waters of the caño find their narrow and tortuous way between banks submerged and densely fringed with mangroves and palms of various kinds; though concealed from the casual observer, its entrance is marked by old wrecks, the remains of previous enterprise. The Stella, a small schooner, or yacht, employed in former examinations and surveys of the gulf, now lies sunk near this boca, its hull alone visible. A small steamer which in years past had ascended the river until near its headwaters, furnished with the necessary machinery for subaqueous gold discoveries, is also sunk there, its boiler being exposed to view above the surface of the gulf. The "Isla de los Muertos" (Island of the Dead) lies to the north of the boca, affording protection against the prevailing winter winds. So narrow is the Caño Coquito—not more than thirty feet in width—that the tips of the oars of a whale boat can simultaneously touch both banks; its depth averages over six feet, whilst its length, with a general southwest course, measures nearly two miles. No soil is visible, and no firmness or consistency belongs to the banks. This is true of all the mouths, and is even the case during the driest seasons. The mangrove and the palm, the highest and most luxuriant growth of this locality, spring up from the water, and mark the narrow belt of land which confines the caño. Back from the caños, east and west, spread immense swamps of many miles in extent, covered with a thin, low vegetation, composed of every variety of plants belonging to this climatic region. From the trees hang suspended an infinite variety of vines and creepers; many of them bear beautiful flowers, and all are matted together in one continuous mass. The low growth is the action of the varied flow of salt and fresh water. During strong northers the saline elements are driven up stream for many miles from the gulf, whilst freshets and

heavy south winds force the river currents across to the opposite shore. The sedimentary deposits of earthy matter borne down from the mountain slopes have for ages back been forming the natural levees which inclose the waters of the Atrato from its very head sources down to the gulf. They increase in height as the ascent towards the mountains is made, forming narrow plateaux along the margins of the river, upon which stand heavy growths of timber; the trees become proportionally high and of increased dimensions as the soil gains a greater degree of stability. Throughout the whole length of the river there is but a narrow belt of the larger sized vegetation; the banks, gradually sloping back from the edge of the water, assume all the characteristics of a wide-spread marsh. At no place along that section of the Atrato, of which examinations and surveys were made, save one, at the village of Boca de Sucio, and that a spot of only a few feet in area, are the banks sufficiently elevated to be exempt entirely from inundation during heavy freshets. Owing, however, to the level expanse of country back of them, the waters spread out far and wide as soon as their channel is no longer restricted within its natural bounds; but at no time, so it would seem, can there be more than one or two feet of water over the banks, as the piles upon which the natives build their houses for protection from floods are not more than three feet high, nor does the river remain up for more than a few hours at a time, as the numerous cuts leading out into the swamps furnish ample outlets to relieve the Atrato of its over-charged currents. It requires no great astuteness of the mind to theorize upon the foundation of the banks or natural levees which restrain within limits the river during its ordinary stages, or to account for the extensive swamps lying behind them. Every moment the same laws of nature which have been operating unceasingly for all time, still quietly and slowly progress in their workings towards the accomplishment and fulfillment of the same purposes. "The atmosphere by its decomposing agency—rain waters, both by their currents and corrosive action, have quietly assailed the surface of rock exposed upon the mountain chains. They reduce this surface to earth; they abraded, cut through, and furrowed out valleys of various magnitudes. The remains or debris of the elevated portions were borne away and spread over the lower, covering them with alluvial." The waters of incipient mountain springs, aided by the falling rain of heaven, grow into mighty rivers, and force for themselves ways to sea, continuing for time after time to bear on their surface these same fragments of earthy matter despoiled from their lake above. They at last deposit them where some counteracting force is met. By this gradual filling in new land is made, and the waves are forced back upon the oceans, which so long nurtured them. Such may have been the case with the Gulf of Darien, or Urabá, whose waters, in centuries passed, may have laved the very base of the Cordilleras. Passing through the Coquito you enter the Caño Barbacoas, which has already widened into a beautiful stream; it is one of the principal arms flowing from the southwest towards the northeast in a very straight course, with but few and no abrupt bends; in width it is over two hundred yards, whilst its depth

averages about thirty-five feet; from the point of departure of the Coquito to where it separates from the Tarena, the largest of the caños, is a little less than seven miles. As the ascent is continued along the east shore of the main river, less than fourteen miles above the latter place, the entrance to the last and highest caño is passed; it is called the Leon, or Urabá, whilst from the right bank of the Barbacoas, nearly midway between the Coquito and Tarena, the Coco Grande takes its leave; the latter, upon examination, has proved narrow, with not much water, whilst the Urabá was found to be broad and deep.

The Caño Tarena, which empties into the gulf further to the north than any of the others, is also called by the natives of the country *Rio madre*, (Mother river;) and from its appearance is well deserving of the title. It follows the general course of the main stream, running in a northerly direction, and is much broader and deeper than the other caños. Through it the greatest amount of water is discharged, being about five hundred yards in width, and averaging some forty feet in depth; the latter is the case until within a short distance of the bar at its mouth, which is reported to be at times almost perfectly dry. In consequence of its unprotected position it is subjected to the whole force of the gulf waves, which break over it heavily during stormy weather. From the course of the Tarena it is necessarily exposed to high winds throughout the winter months, and owing to its great width and uniform direction with the main river, heavy waves are caused by them, rendering the latter rough and turbulent. At such times it is difficult for small boats to cross from one bank to the other. The winds are not unfrequently felt for more than a hundred miles above its mouth; the waters for that distance even then become very sensibly brackish, as those of the gulf are driven up. During these northers a current is apparently formed up the stream, and the river boats sail up to Boca de Sucio, a distance of seventy-five miles, in two days; owing to the low banks they have a fair open sweep. In consequence of this state of affairs, during the descent of the river in February, it was impossible to obtain accurately the velocity of the flow by the ordinary trials of the log. A short distance below the point of separation of the Barbacoas from the Tarena the Caño Parvo leaves the latter to the south, and when within a short distance of the gulf loses portions of its own waters through the Caño Candelaria. This latter caño empties into a bay of the same name, said to possess good and safe anchorage grounds and sufficient water. The Pantana and Pedro are outlets from the Coco Grande, and the Urabá, Urabacito, Pedrito, Pichindi, and Pichindicito are small arms of the main Urabá. Through the latter and the Pichindicito, both reported to be of sufficient breadth, and with depth great enough to float vessels of the heaviest tonnage within a short distance of its mouth, a good ship channel can be made at but little expense to connect the Atrato and the gulf. In common with all rivers discharging their waters into open seas, the entrances of the mouths of the Atrato, one and all, and to a greater or less extent as their position lay more or less exposed to certain extraneous actions, are impeded by tidal bars, which very materially affect ship navigation.

These bars are formed by depositions of alluvious matter which in-

variably occur when antagonistic action takes place between the currents of rivers and the tidal waves of oceans. The fresh waters, bearing along the washings of the plains and mountains above, meet and are intercepted by the salt waters which keep in perpetual turmoil the sands from the bottom of the sea, and together, mingled in one mass, seek a common bed. They stretch entirely around the delta formation, through which the river pours its waters into the gulf. There is no perceptical current in the gulf, save that created by the rush of waters from the Atrato. As one force or the other predominates, whether strengthened on the one hand by a river flood or on the other by heavy sea winds, these bars are pushed further from or brought in close proximity to the mouths. They undergo many displacements, some of them very sudden, according to the predominating force and the rapidity of its action. Held for a time in a semi-fluid state and composed of very minute particles, this sediment at length becomes hardened by the constant beating of the tidal waves, and in the end forms serious impediments to the egress and ingress of suitable trading boats from and into the river. After passing their bocas or mouths the caños generally become very deep. Floating trees and logs and vegetable drift become sometimes embedded on these bars, but more frequently they are washed out of the channel on to the shoals near the banks. They there form a nucleus to which other swimming matter may catch and cling, and around which new alluvious deposits form; vegetation then rapidly follows, and each succeeding growth gives stability to what before was floating drift. Islands and necks of land are thus made, which by their gradual encroachments steal away the domains of the sea. The most efficacious plans for removing these impediments to free ship navigation will be treated under their own proper head among the engineering problems for constructing the interoceanic ship canal.

As the view of the main body of the Atrato broke upon the vision, when nearing the point where the waters of the Tarena and Barbacoas divide, it was impossible to refrain from expressing the most unbounded admiration of its grandeur and gigantic proportions. Imagination had pictured the river far less noble, and considerable credulity was necessary to encourage the belief that the narrow, tortuous Coquito lead into a highway so grand and propitious for the encouragement and advancement of a great commercial enterprise. Whilst gazing upon its expanse of waters, broad, deep and magnificent, coursing along in all their strength and majesty, a mind disposed to admit the wisdom and goodness of all created works, and their adaptation to the requirements of mankind, must in truth acknowledge that there is a providence in the present geographical position of this large river and its tributaries. Their waters lead the way from the Gulf of Darien, on the Atlantic coast, to within a few yards of the very summit of the low chain of hills which now forms the connecting link between the lofty mountains of the two great continents of North and South America, and have almost by their own force cleft that narrow, natural dyke, separating the waves of two mighty oceans, which needs but to be pierced by the power of man to let their waters freely intermingle. The banks of the Atrato, near the caños, are not generally visible, save in very driest seasons; though scarcely even with the

water's edge, still the waves are walled in by that denseness, richness, and beauty of vegetation witnessed only in tropical regions. Notwithstanding it was the season of chill blasts and winter snows in the land of homes but recently left, still here the deep green of the leaves had not been touched, and the thick foliage remained impenetrable to sight; the vines, twined together in masses, were suspended in graceful festoons from the limbs of trees, and the wild profusion of beautiful flowers still retained all the richness of their variegated hues. The broad and straight bed of the river affords an open way through which the winds from both mountains and sea have uninterrupted access, purifying the atmosphere and making it fresh and salubrious. This free action of the air of heaven, combined with the genial warmth and light of the sun, and the richness of the alluvial soil, render the vegetable walls facing the river remarkably fresh, brilliant, and profuse. From the delta to the mouth of the Truandó, the river preserves the same regimen; the banks gradually become higher and higher and higher, with scarcely a place, however, free from overflow; excepting in very dry weather, they possesss so little firmness as to offer but few spots upon which to rest a foot without miring deep into the mud. The swamps reach back to the base of the mountains. The vegetation undergoes also some slight changes. The various palms which mark and beautify the river's course for many miles above its mouth, only scatteringly appear after the first low range of hills approach its bed, gradually giving way to a heavier and larger species of timber. A long, coarse, aquatic grass, called by the natives grammalote, takes root and spreads in luxuriant growth along the convex and shoaler banks of the different bends. It plays an important part in assisting the bogas or boatmen to pole up stream, the depth of water being too great to reach bottom. The forked palancas, or poles, by means of which the boat is impelled forward, are pressed against the grass, and the latter admirably answers the purpose of a fulcrum. Several tributaries, partaking of the nature of the Atrato, pour in their supplies at different points, but only to a small degree augment the already large volume of water. They severally bear the names of Tumarador grande, Cacarica, Tumaradorcito, Hondo, Boca larga, Guachuco, Salaquí, Sucio, and Truandó. These rivers, with their many branches, form the only highways from point to point, recourse being had to light canoes for traveling through this wide extent of country. The average width of the Atrato, from the Truandó to the Delta, is about eleven hundred feet, with a mean depth of fifty; thirty feet can be carried within a few yards of the banks as they fall off rapidly, and are seemingly vertical. Not unfrequently the depth of the river exceeds one hundred feet. The banks vary in height, from complete submersion to five or six feet during the ordinary stages of its waters. They do not crumble away very much, as in most rivers of the same dimensions, the soil being clogged by the very finest texture of roots woven and interwoven together, and constantly kept in a moist state by the humid atmosphere and the denseness of the shade. Broad, and deep, and clear, the waters were pleasantly cool and refreshing to the taste. The river does not pursue a very meandering course; its bends are but few in number, with long, intermediate,

straight stretches; the general course is remarkably direct, with but slight deviations. This is principally owing to its deep, swift current, the great fluid mass having forced every obstacle before it. The low banks would offer but little resistance to its encroachments had not the bed already assumed a fixed regimen. Notwithstanding the great width of the channel of the river, there occur in it no obstructions from snags or sawyers, and only a small number to be found within a few yards of the banks. Floating islands of vegetables drift, and swimming logs of large dimensions were sometimes encountered. One of the former, during the ascent of the river, caught the line attached to the anchor of the whale boat at night, and in the morning all on board awoke to find that she had been forced down stream more than a mile. The greatest succession of bends occur when coming near and in close proximity to one of the spurs of the San Blas mountains, called the Cacarica hills, which approach the river on its left bank; stretching from the west, they break, for a time, the general course of the river, which winds around close to their base. On the right bank, a singular lonely mound is also passed, as remarkable for its appearance as for its isolated position. It is of no great elevation, and is called by the natives "Cerro de Tumarador." It is not far distant from a tributary of the Atrato bearing the same name. Anchoring in the middle of the channel, a few miles above the mouth of this stream, an opportunity presented itself for enjoying a most magnificent view of the distant mountain ranges. The scenic effect was heightened by the foreground of the picture, presenting a long beautiful reach of the river, lined with rich tropical borderings. The whole was lit up by the gorgeous cloud tints of a setting sun, whose rays, playing on the surface of the water, were reflected back in glittering spangles by the tremulous action of the waves. Before reaching the Tumarador hill, the last of the caños is left behind, and the river there strictly confines itself to one bed. Its banks gradually emerge from the water, and at the stage of water existing at the time of its ascent, were some two feet high, but still so unstable as scarcely to bear the weight of a man. Along this section the highest water mark, discernible on the bark of the trees, was not three feet above the surface of the stream. Owing to the constant rains, and the denseness of the vegetation, preventing a free circulation of air and the penetration of the warm rays of the sun, the banks never become thoroughly dry, even in the most favored seasons. Although each day's progress up the Atrato was slow and tedious, exhibiting but little variety in landscape view, still the ever varying changes in both the animal and vegetable kingdoms, kept the mind constantly on the alert for something new and strange. The height of the timber very often precluded any very extended vision, and only that portion between Tumarador and Cacarica affords much scenic variety. There the high hills of Cacarica push forward in great boldness of outline, and, whilst making the bends more abrupt and irregular, gave a frequent opportunity of observing, at many points, the varied views afforded by the boat's changes of position. Back, behind these hills, high blue mountains rise up to several thousand feet in elevation, truly lending, by their distance, "enchantment to the view." All appeared to be densely covered with timber. Whilst

rounding them the channel is quite sinuous, but no reach so short as to interfere with navigation for the largest sized vessels now afloat. In many respects the Atrato and the Lower Mississippi resemble each other in appearance and regimen. Both are lined with dense forests for miles above their mouths; but whilst the growth along the one is possessed of great sameness, the vegetation of the other is profuse and luxuriant in its varieties. The leaves are beautiful in themselves, and arbors of rich green vines hang far out over the waters. Almost every tree and vine and shrub bear flowers, hanging in magnificent clusters of every hue and size and shape. All have admired those rare plants and flowers which ornament both the public and private conservatories of the temperate zone, and which are nursed with such exceeding care that scarcely a breath of free air is allowed to fan them, and where artificial heat is made to replace the genial warmth of the sun's rays. Imagine them, instead of being trained and nurtured by the hand of man, allowed to grow in wild confusion, and in all the luxuriance of nature's handiwork, and a faint idea can then be formed of the beauty which daily gladdens the sight in the tropical world. The spicy aroma of tree and plant, mingled with the fragrance of bright flowers, and their fruit, which "spirits odorous breathe," are diffused throughout all surrounding space. This happy blending of bright colors with sweetness of scent and climatic charms, at times steal away the very senses: a feeling of listlessness enervates the body, whilst soothing and delicious musings and reveries are left to chase each other through the labyrinths of the brain. Strong efforts are at times needed to dispel the charm, and awake the mind to a stern realization of the duties to be performed.

ANIMAL KINGDOM.

The animal kingdom is equally full of life. A shot from a gun at early dawn on the second morning of the ascent of the Atrato, seemed to awaken from profound silence all animated nature: birds and animals were at once startled into a state of wild commotion, all joining in one great chorus of screams, and cries, and howls. A loud, deep, and continuous roar apparently at but a short distance from the boats, caused the greatest surprise. The many surmises as to whether the sounds proceeded from the jaguar or the peccary, were at last dispelled by finding that they emanated from a species of large red monkey of the roaring kind. When not very near them, the noise resembled the deep guttural grunts of a drove of wild boars in an angry mood. The effect upon this wild animal creation is terrible in the extreme during the continuance of those furious tempests which at times rage over the country. Those dreadful peals of thunder which follow the terrific plays of lightning in the tropics, cause the woods to resound with yells of fierce anger or cries of timidity, as some are lashed into fury and others cowed down by fear of the raging storm. All along the Atrato, the various species of the monkey tribe were heard constantly, chattering, or roaring, or whistling among the branches, as they migrated from tree to tree in search of insects or nuts for food; or perhaps they would be seen engaged in making a thievish attack upon the families

of some old antiquated storks, perched upon the topmost limbs of the highest trees, whose wild, shrill, and piercing cries would vibrate through the air as they fluttered over their nests in defense of their young, or to preserve their eggs from the palates of their lawless tormentors. A few shot thrown among the rascally, cunning intruders, caused them to desist from further agressions, and to turn their attack upon a boatman who landed to carry off one of their companions fallen in the action. Several kinds of monkey were daily seen of different sizes, colors, and habits. Among these the sloth, too lazy to live, which, after hanging with its long claws to a limb until all food within its reach is exhausted, lets go and drops to the ground; with a pitiful, innocent looking face, it utters most plaintive cries, as, owing to the tenderness of their bones, the fall causes them great suffering. The tiger, peccary or wild hog, tapir, and manatí, are said to exist, but few or none were seen. The closely cropped grammalote indicated the presence of the last, and the large impress of the paws of the first along the banks of the river well authenticated the truth of their formidable size and great numbers. Several species of smaller animals exist. Of the reptiles and fishes, there were many interesting varieties. Of the former, alligators, of formidable dimensions, and iguanos were very numerous. Although snakes are reported to exist in large numbers, still but few were seen. Neither the *Vibora de Sangre*, of Central America, whose sting so affects the blood as to cause it to pass through the pores of the body in streams of profuse prespiration until death relieves the sufferer, nor any of the venomous species for whom the natives manifest so much horror, came under the observation of the party. Some few specimens were caught and preserved for future examination. Knowing, as they profess to do, so many efficacious antidotes against the deadly poison of their bites, they nevertheless stand in more than wonted dread of them. So great is their superstition, that, on the occasion of one having been killed and temporarily laid on the deck of the bungo to be preserved, fearing some direful consequence might accrue, they placed live coals and ashes on the spot after the removal of the specimen, in order to purify it by fire. Large schools of fish were seen at times sporting through the water, comprising many new and interesting species. Several kinds are possessed of fine flavor, of which the natives catch large numbers. They are dried in the sun and smoked for preservation, forming one of the principle staples of river trade.

The flight of the birds constantly attracted the attention; the gay plumage of the parrot and mackaw, soaring in pairs high over head, could be admired in all its richness and variety of color; hosts of others of the feathered tribe enlivened by their varying notes the splendor of the natural scenery. That noble and beautiful bird, the pavo, or wild turkey, with its spread wings, resemble in appearance, but in call differs from the domestic species; it was not unfrequently seen roosting on the highest trees. The blue and the white crane would ever and anon move gracefully along in advance of the boat, their flight contrasting greatly with the labored efforts of the ungainly stork; while the kingfisher and the toucan, and divers of various colors and sizes, were swiftly skimming along the surface of

the water in pursuit of their daily sports. Many of the very small, delicate varieties of birds even were seen; one little beauty, with a golden head and black body; another like the canary in size and color. Black birds of a large kind made the trees and shrubbery echo with their clear, cheerful whistle; also a beautiful diver, having a yellow body and black wings, and with spurs for attack and defense, was seen; and numbers of those charming paroquites, clothed with fine, rich green plumage. To give an idea of the number and variety of the animal kingdom which meet the eye at almost any moment, let a leaf from notes along the Atrato, taken on the spot, be here introduced: "Our boat is now lying at the mouth of a large stream, some twenty-five feet in width, named La Larga; a small clearing has been made by the natives, a temporary habitation or stopping place, whilst engaged in fishing or in search of caoutchouc. An immense ants' nest, spherical in form and about two and a half feet in diameter, hangs suspended above the ground from the limb of a tree. Rowed up the stream some little distance to get a turkey; one was shot, and whilst endeavoring to reach it, a hawk pounced down for his share, but met a similar fate; failed in getting either, the thick grammalote preventing a near approach to the bank. It may seem incredible, but whilst lying in the stream, there are to be seen at the same moment, within gun shot range, on the surrounding trees, two turkeys, one hawk, two trees full of monkeys, one species of the whistling, and the other of the roaring kind, two macaws, six white cranes, and one blue, and several small birds flitting around about. An alligator also lies asleep on the surface of the water, whilst some large fish are jumping and playing near the boat." As it was impossible to land to bag the game, it was useless to shoot. We sat and watched them as they fearlessly enjoyed their noonday's rest, nestling beneath the dense foliage and shaded from the warm rays of the sun. To every appearance "it is here as in Paradise," groups of creatures belonging to the most opposite species of animals come to drink, to bathe, or to fish; but the gentle peace of the primitive golden age does not reign in the Paradise of these American animals; they stand apart, watch, and avoid each other; the lion and the lamb do not lie down together in sweet pastures. Many of these birds and animals, as well as of the reptiles, furnished food at different times to the party; some of them tickled the palate by their delicacy. Along the Atrato both monkies and turkeys formed agreeable additions to the ordinary rations. Subsequently, on the Truandó, the eggs of the alligator and of the Iguana, as well as the flesh of the latter, proved very acceptable.

The peccary, at times, also furnished a comfortable meal; and on a certain occasion one was most opportunely provided by some Chocó Indians, otherwise there would have been a hungry party in camp. But a single deer was seen during the entire expedition, and although it stood spell-bound for a moment among the enchanting wildnesses of the valley of the Truandó, still no unerring shot transfixed it to the spot, nor did its choice viands grace the table. The different fish were found to be possessed of an unusually fine flavor, and generally very abundant; the Indians successfully displayed their skill in catching them. The world of insects never sleep; day and night the buzzing

noise never ceases to be heard; even at noontide, when in the tropics all nature seems to be wrapt in sweet repose, the continual humming still goes on. "Everything proclaims a world of active organic forces; in every shrub, in the cracked bark of trees, in the perforated ground, life is everywhere audibly manifest; it is one of the many voices of nature revealed to the pious and susceptible spirit of man." In the lower Atrato a large white winged fly, the congo, remarkable for its celerity of action and the severity of its bite, required a good share of one's attention to be freed from its importunities. At Turbo there was a species of gnat, called by the natives jejenes, which made their attacks by day, especially on the sand beaches; and another branch of the same family came to the relief of their associates, and operated entirely at night. Along the river a near approach to its banks would be certain to surround the boats with swarms of gnats, whilst lines of ants, of numberless species, were seen to extend their labors to each branch and leaf and flower; the plucking of either would introduce the greatest numbers, and cover every article. Nests of wasps and hornets are sometimes attached to the overhanging limbs; as the bungo approaches them, the monotonous chant of the native bogas ceases, the most perfect silence reigns on board, and she is allowed to glide quietly by, fearful of arousing their irascibility.

But what proved most annoying and vexatious were the myriads of musquitoes that infest the lower portions of the Truandó and Atrato. The term musquito is only applied by the natives to what are here called gnats. The musquito of this part of the world, with the long bill and long legs, is there known as the zancudo; they present every variety of shape and color. By day the buzz and sting of the numerous family of flies would excite and irritate the most patient; but from the set until the rise of each day's sun, twelve mortal hours out of every twenty-four, the interminable singing and insatiable thirst of the various and ferocious tribes of musquitoes at times bid defiance to sleep and made night hideous. The increased numbers among the vegetation of the humid shores, sheltered there from the winds which freely blow along the river, necessitated the anchoring of the boats in the middle of the broad stream in order to obtain the slightest degree of comfort. The few persons who had taken the precaution to supply themselves with the ordinary appliances of bars or nets suffered but little from the blood-thirsty propensities of these insects. Those who had not done so nightly bore bitter testimony to the spite and concentrated wrath of their malicious tormentors. A large and valuable collection of mammals, birds, fishes, reptiles, and insects was made by the naturalist of the party, enlarged by the chance additions of others connected with the expedition, and forwarded to the Smithsonian Institute, at Washington, for examination and classification. It is a source of great gratification to be able to state that the gentlemen engaged in these pursuits have been successful in discovering and making known many new species among the different general classes of the animal kingdon.

VILLAGES—INHABITANTS—BOCA DE SUCIO.

Owing to the instability of the banks, so boggy in their character, and the extensive swamps behind them, there are in reality no habitations along the lower Atrato. The only village that exists along that portion of the river ascended lies immediately below the mouth of the Sucio, one of its largest tributaries. This stream flows in from the east or right bank a mile and a half below the principal mouth of the Truandó and immediately opposite the entrance to one of the caños of the latter called the Salaqui. Occasionally the San Blas Indians visit the Caño Tarena to fish; they erect temporary huts, but their canoes are ever held in readiness to migrate at the very first indication of a flood. During these temporary visits they are said to have interfered at one time with the Atrato trade by attacking the Bogas, who stand in great dread of them. The lattter in speaking of these Indians invariably apply to them the epithet *muy bravo*, (very brave,) showing the great regard they entertain for them. The navigation by the Tarena caño into the gulf is said to have been stopped on that account. A sub-tribe of the same Indians frequent the Cacarica tributary, from the headwaters of which a portage is reported to exist across the mountains to the Pacific. Some native Spanish negroes were met ascending the river from Boca de Sucio *en route* to the Tumeradorcito to collect caoutchouc. At the mouth of the Hondo several huts remained standing; the San Blas Indians also visit them to hunt and fish.

The village *Boca de Sucio* is scattered over some five or six acres of ground; the soil is a mixture of clay and sand, and possessed of sufficient firmness and solidity. Although a tremulous, shaky motion is perceptible when heavy bodies pass over it, it is protected by its situation from any immediate danger of being entirely effaced from off the surface of the earth, should a sudden freak of nature in the way of an Atrato freshet attempt it. The space allotted for building purposes is very limited. Immediately back of the few houses of the village, here as elsewhere, spreads out the interminable swamp. Although the first place at all suitable for the purpose, still its advantages are doubtful and its charms "few and far between."

The houses are built in the same style and of the same material as those at Turbo. The principal person of the place was Señor de la Rosa, a Spaniard by birth, and agent for Mr. Dean in the caoutchouc trade. With the exception of himself and one or two others of Spanish origin, the remaining inhabitants, numbering between eighty and ninety, were of every possible gradation between the white, the negro, and aborigines of the country. A large portion were children under ten years of age, growing up innured to a climate of which they have but little dread. Even in this distant spot, far away from city and town, and almost buried in its own seclusion, that great monster *death* had also entered and marked for his own one of the most shining lights of their rude but happy homes. On entering for the first time the principal residence of the place, into which the Spanish Caballero invited some of the party, a sad sight met the gaze.

There lay, in one portion of the room, as if reposing in sweet sleep, the corpse of a beautiful young girl. She was wrapt in a white shroud, over which lay scattered beautiful flowers, a wreath of them encircling her head; lighted tapers, after the custom of the Catholics, were burning around her, whilst mourning friends kept their last watch over her remains. In another portion of the room could be seen those busily engaged in arranging the coffin and dressing it with the symbols of childhood, not neglecting, in this obscure locality even, the smallest of those last sad attentions which all love to bestow upon the dead, and which dispel so much of the gloom and terror of the grave.

The women are either negroes or Chocó Indians; their dress is simply a blanket girt about their lions, covering the body from the hips to the knees; a bandana handkerchief is sometimes tied around the neck and allowed to hang down in front, to conceal the breasts.

The village is principally an agency for the collection of caoutchouc, the ivory nut, and cacao. Supplies of provisions are kept on hand for furnishing the bungos plying between Cartajena and Quibdo. The latter place is one of the last settlements on the Upper Atrato, and at the head of bungo navigation. Also, different commodities, such as trinkets and beads, can be had for barter and sale to the Indians. All the domestic animals, cattle, pigs, poultry, cats, and dogs, although few in number, save the last, and with but limited space in which to roam, seem to thrive there in spite of the unpretending appearance of the place; several of the creature comforts could be had; excellent chocolate, made from the best of cacao; very passable cigars, whose greatest virtue consisted in the cheapness of their price, and which by dint of hard puffs would finally end in smoke and ashes; very strong anisado, distilled from rice and flavored with anniseed, the delight of the natives, together with very good Jamaica rum, formed the chief beverages of the inhabitants.

Several kinds of fruit trees were growing there; the mango, beautiful with its dense green foliage; the guava, its ripe fruit tempting to the palate; the lemon, growing to a considerable height, and loaded with fruit, and a beautiful tree bearing the calabaza, resembling in kind the gourd of this country, only much larger, from which spoons and cups are made.

Plantains, or, more correctly, platanos, were brought from a settlement above, on the Sucio; these, together with rice, fish, chocolate, and the occasional results of the chase, peccary and monkeys, form the principal articles of nourishment. To Señor de la Rosa the engineer corps are particularly indebted, especially on the return trip from the Pacific, for the very valuable aid rendered by him, at a time, too, when it was greatly needed; also, for the great interest manifested by him in the successful termination of the expedition, and for the hopes expressed by him as to the final result of its labors. His generous hospitality during the brief sojourn of the party at Boca de Sucio, cannot be too highly commended. Nor, in this connection, can the kindness of Don Carlos Dean, of Turbo, be forgotten, who so kindly forwarded letters in advance to his agent, to request him to render every assistance in his power to further the great object of the enter-

prise. The Atrato, as high up as the village, and for a great distance above, still preserves the same regimen, the banks gradually becoming higher and higher, but at no place entirely free from overflow. At the time of its ascent, during the early part of the month December, 1857, the banks near the highest spot of the village were found by measurement to be four feet and four and a half inches above the surface of the water, which was said to be at about its lowest stage. The mark of the highest freshet known to the inhabitants was three and a half feet above the same point, making a difference of level between the extreme stages of the river seven feet ten and a half inches.

On returning to the same village in the latter part of February, 1858, three months later, and after a very remarkably dry season, the banks were found to be nearly eleven feet out of water—making the difference of level between the extremes about thirteen and a half feet. This was, however, an extraordinary state of affairs, and is not of very frequent occurrence. Those who had resided for the greatest period of time on the river, could not recall to mind a similar one. During the same month of the previous year the waters had risen to such a height that the inhabitants were compelled to use canoes in passing from house to house. This great range of waters must, of course, be of the first importance in the consideration of the various elements entering into any contemplated improvement of the Atrato, and more especially in prosecuting so grand a work as a ship canal connecting it with the Pacific ocean.

The river rises quickly, but falls with like rapidity; its long length and great breadth, together with the wide extent of swamp over which the mountain floods spread at the time of high water, soon reduce it to its ordinary average level. Owing to the extreme dryness of the season at the time the survey of the Atrato was made, the banks had become quite high and firm until within a few miles of the boca of Caño Coquito, sufficiently so for camping upon them during each night of the descent. For the first time there was some positive evidence of the existence of tigers along the river, their huge tracks then became visible close to the water's edge at every station.

TEMPERATURE ALONG THE ATRATO.

Whilst ascending the Atrato, between the 9th and 16th December, the atmosphere was very uniform, the thermometer varying from 79° to 83° Fahr., between the rise and set of the sun; protected from its rays by the boat awning, no inconvenience was felt from the heat during the day. The nights were, in general, exceedingly cool and pleasant; the netting used against the attacks of mosquitoes proved sufficient protection from the slight changes of weather, keeping off not only the moisture of nocturnal dews, but also the night breezes and any floating malaria; no other covering was needed, as from necessity each man was compelled to sleep in his customary daily clothing. This was anything but pleasant, but caused a much greater appreciation of the only actual comfort known whilst confined to the limited space on board of the boats, namely, the privilege of sleeping

without boots. Those of the party who did not possess mosquito bars never even dare indulge in that luxury. During the ascent of the river little rain fell, notwithstanding the oft-repeated representations that the valley of the Atrato was daily drenched by heavy showers; there was but little cause of complaint in that respect. For the first time, on the evening of the 12th, the weather became quite sultry, and continued so until midnight, when it rained heavily for an hour or two; towards morning it again poured down for a few moments.

On Sunday, the 13th, the sun shone only at intervals; heavy clouds threatened to let down their torrents during a greater part of the morning. For the first time, however, the stars and stripes were floated to the breeze and waved over the waters of the great Atrato. During the night of the 14th it rained slightly for a short time. The thermometer on the following morning, at break of day, stood at 78°, by ten, a. m., at 80°, and by noon at 83° Fahr. About three o'clock on the afternoon of the same day, the 15th, whilst passing the mouth of the Hondo, a heavy rain commenced to fall and continued for one and a half hours; at sunset the thermometer indicated 82°—the night following being deliciously cool. To give an idea of the temperature of a day on the Atrato, and there one is but the repetition of another as regards uniformity in its meteorological characteristics, the above details have been set forth somewhat minutely.

On the return trip, whilst engaged in making the survey of the Atrato, between the 20th of February and 4th of March, there was but one slight sprinkling rain, the weather being at all times remarkably mild and pleasant. The bright days were cooled by the refreshing winds from the north, and the clear nights courted quiet slumbers, as anchored in the middle of the stream, away from the pest of insects, the same balmy breezes came wafted along the waters, bearing fragrant perfumes of sweet scented flowers, they played gently over the sleepers as they lay stretched on the deck of the barquetona, with naught but the canopy of heaven for a covering.

The remembrances of the climate of the Atrato are certainly agreeable and pleasant.

TRANSPORTATION—BUNGOS—BARQUETONA—LIFE-BOATS—CANOES—BOGAS.

Before leaving the general description of the Atrato, an account may not be inappropriately given of the kinds of transportation used by the parties engaged on the different surveys.

The flotilla for the ascent of the Atrato consisted of one large river boat, known by the natives as a barquetona, and which bore the name of La Concha, two of Francis's metallic life boats, and the ship's whale boat. The latter was sharp at both ends, about twenty feet in length, and its greatest width some five feet. It carried the two officers of the Navy and Army, who were individually in charge of the hydrographic and topographical parties of the expedition. The boat's crew numbered four oarsmen, sailors from the schooner, and one boy as cook. In addition to officers and men, there had to be stowed away on board the private effects of each person, and camp equipage, besides several small instruments and seven days' rations.

From the time of leaving the gulf until the first camp established on the Truandó, a period of two weeks, all were compelled to live day and night upon the boat. The barquetona of the country is a large river boat, and presents a very uncouth appearance. The one engaged for the expedition was about seventy feet in length from stem to stern, and nearly sharp at both ends. In breadth of deck she measured about ten feet, and drew from three and a half to four feet of water when loaded. Some six feet of deck a little aft of midships is slightly raised above the main one. The portion of the boat thus divided off is intended as a saloon, but too low for an ordinary sized man to stand erect. Forward and aft are the holds for freight. A low shed of boards had been erected over part of the deck to afford shade during the day and for protection from night dews. This covering, called by the natives toga, is invariably thatched by them with the coarse grammalote grass, and made sufficiently low in order not to be brought in contact with the limbs of trees as the boat hugs the bank during her ascent. The Concha was employed to transport the astronomical and surveying instruments and the supplies of provisions for the expedition; also the camp equipage, arms, and ammunition, and private effects of the passengers on board of her. This party was composed of two first class, four second class, and seven third class assistants, the surgeon and hospital steward, the guide, the ship's carpenter, two servants, seven native macheteros or axmen, six boatmen or bogas, and the patron, who takes charge of the rudder, whilst at the same time he directs the general working of the boat. Thirty-three persons were packed away day after day and night after night for two weeks on the small deck of the barquetona. It must be remembered, also, that as the banks of the river at that time offered no firm spot upon which to camp, all the necessities of life had to be performed on board. It requires no very great stretch of the imagination to conceive of the very great discomfort experienced by all her passengers. Many of them had left comfortable homes to add their names to the list of those perilling health and even life itself for the honor of being associated with the germ of a great and magnificent enterprise. The bogas impel the boat forward by poles or palancas, forked at one end. Owing to the great depth of water in the channel of the river, the bottom cannot be touched by them. To overcome this difficulty, the boats having been run close into the shore, the forked ends of the poles are planted against the limbs and branches of trees, or against the luxuriant growth of coarse grammalote, which extends along the convex sides of the banks. To gain this advantage the river is frequently crossed and recrossed. The presence of this grass expedites the movement of the boat very much, and when able to make use of it the speed is much increased. The higher the Atrato is ascended the thicker and more overhanging the branches become, increasing considerably the difficulty of urging the boat forward. The bowman has a hooked pole with which he catches the passing limbs and vines, and thus keeps near the banks. The bungo, like its twin sister the barquetona, is far from being perfectly modelled, and possesses very little symmetry of shape. It is larger and of greater draught than the latter, although very similar in appearance. It is generally used for

river navigation by the natives, and sometimes for the coasting trade of their country. The bogas or boatmen are natives of New Granada, mostly negroes; a strong, muscular race, and well adapted for the arduous pursuits followed by them in the tropics. They at all times appear good natured, and when well managed and well fed, labor hard and industriously. During the hours of work, from early in the morning until late in the evening, they unceasingly sing a monotonous chant, keeping perfect time, to the tune of which they tread the deck, and plant their palancas all day long. Without intermission the song is kept up, save when rowing from one shore to another. On entering the mouth of the Caño Coquito, the crew offer up a prayer for a safe trip. To a stranger to their language and habits, the loud, shrill chant strikes upon the ear as if it were the utterance of some dire calamity, instead of a plaintive appeal to the saints in heaven for a propitious journey. Silence is also preserved among the bogas upon approaching a tree upon which hangs suspended a wasp's nest. To avoid being stung, they take especial care not to touch the limb or branch with the palancas. Their keen sight is ever on the watch for venomous snakes. The latter are occasionally precipitated on deck from the overhanging branches in which they lay coiled up. Their food is very simple, consisting chiefly of a salt dried beef, yams, plantains, and occasionally rice. These are generally all boiled together in an iron pot, making one mess. When at work the bogas strip to the skin, save a small garment which covers the hip and thigh. This is kept constantly moist, and their bodies refreshed and cooled by frequent application of water, thrown over them by the bucket full. As the evening shades appeared, quiet was generally restored over both the boats. With the setting of the sun came the fierce attacks and interminable buzzing of the mosquitos, and each person sought refuge and repose under his net. The first peep of day found all stirring, too anxious to throw off the slumbers of a long tropical night. During the two weeks of confinement in the ascent of the Atrato, and up to the first landing on the Truandó, the limbs of those in the whale boat were kept in very constrained positions, owing to the cramped and limited space allowed each person. Although the awning, so useful in other respects, prevented any change from a sitting to a standing position, the body being kept all day long in a semi-recumbent position, and relief only being obtained at night by stretching out at full length along the thwarts. Still all kept well. The deprivation of customary exercise, in consequence of the inability to land on the semi-fluid banks of the river, save at Boca de Sucio, seemed to produce no ill effect.

As it was impossible to carry the Barquetona more than twenty-six miles up the Truandó, to within a short distance of the spot pitched upon for the first camp on *terra firma*, it was there discharged of its freight and sent back to Cartajena to return with additional supplies. The whale boat, owing to its build, continued to be of service only a few additional miles beyond the same point. The life-boats of the same pattern as those in daily use on the Atlantic and Pacific sea-coasts, were towed astern of the Barquetona during the ascent of the Atrato, and subsequently proved of the most indispensable value in the survey

of the Truandó, as high up as the falls or saltos. The difficulty of carrying them over the latter necessitated the leaving of them there until the return trip again called them into requisition. Above the first camp on the Truandó the friendly Chocó Indians, with their light canoes, rendered most effective aid during the ascent of that river, and also the Nercua to the mouth of the Hingador.

A description of these canoes, with an account of their capabilities for transportation, will not be out of place. Without their assistance but little would have been effected towards accomplishing the objects of the expedition. Each canoe is dug out from the trunk of a tree, and, considering the nature of the tools used, the workmanship is extremely well executed. They vary much in size, from ten to thirty-five feet in length, and from one to three in breadth; but lightly built, and drawing only a few inches of water, they can be carried over any ordinary river obstructions, such as sunken or fallen trees, rapids, or falls. When pushing them over fallen trees but partly submerged a peculiar slippery bark is often cut and placed upon the trunk on which to slide them. In deep water they are generally impelled with paddles by two persons, one in the bow and one in the stern. In shoal water and up rapid currents the palanca or pole is substituted by the bowman for the paddle, the greatest skill and dexterity being required to guide them. They are managed with great ease, and apparently with little labor. The keen eye and steady hand of the native carry them up and down rapids and falls in perfect safety.

One of the larger sized canoes arrived at Boca de Sucio from the Indian village of Pavarandó, on the Rio Sucio, a few hours after the party first reached there. The following articles constituted her cargo and will give some idea of her capacity for transportation. In the bow sat a native with his paddle; close behind him was a box filled with sand used as a fireplace, some plantains roasting on it at the time; then came several large bags of oranges, over which had been thrown two or three hundred plantains and some sun-dried fish. Amidships there was built a toga, a low covering made of vines arched from side to side of the boat and thatched with palm leaves. Under this the patron or traveler crawls during the night to sleep; his blankets and musquito netting were lying in it. Next to the toga came two large wooden chests for clothing and other effects; then four large pieces of caoutchouc in its crude state, and weighing two hundred pounds; over these lay a bag of oranges and a hundred plantains. Then appeared Senor de la Rosa, the gentlemanly proprietor of the establishment, and behind him the second peon or laborer with his paddle; at the stern of the boat lay a large dog, a usual accompaniment of all such expeditions. On the roof of the toga two game cocks were tied, crowing most defiantly. A gun and two spears for fishing complete the list of the cargo. Altogether, unless an eye witness, one could hardly credit the compactness of the whole establishment. If the usefulness of these canoes and their advantage over the boats employed in the ascent of the Truandó had been earlier realized, a great deal of time would have been saved and much labor and anxiety spared the members of the expedition. The kind of transportation adopted in crossing

the Cordilleras de los Andes will be referred to in a subsequent part of this report.

TRUANDÓ—SUCIO—SALAQUI—NERCUA—CORDILLERAS DE LOS ANDES—PACIFIC OCEAN.

The junction of the Atrato and Truandó is the chief point of interest along the line of survey of this particular route for an interoceanic ship canal. Here the mind first begins in reality to have some conception of the nature of the difficulties to be overcome in order to insure a successful accomplishment of a most important work, which the world must ever regard as one of the greatest and most useful labors ever contemplated in this or any other age. Between this point and the Pacific ocean lie all the obstacles to be surmounted. The elevation of the junction above the mean level of the two oceans, and its distance from the Pacific, are questions upon which depends the success of the enterprise, and which give rise to most interesting hydraulic problems. The heights of the intervening plateaux and mountains must decide the quantities of earth and rock to be excavated and removed, whilst the rivers and streams are called upon to demonstrate their ability to feed a canal of dimensions sufficiently large to meet the demands of the whole commercial marine. It therefore becomes necessary to enter more into the minutiæ of the various details of the surveys and examinations made after leaving the Atrato. Let the devious and uncertain steps of the party, as it slowly progressed with the work, be followed from day to day. Go with it up the Truandó to the mouth of the Nercua; thence up this stream and its tributary the Hingadór, and across the Cordilleras de los Andes, to the waves of the Pacific. The description will endeavor to be sufficiently full and copious in regard to the physical features of the country, that all who read may judge of the correctness of the conclusions drawn, whether favorable or unfavorable, as to the possibility of constructing a canal. The noble Atrato, capable of bearing on its waters the largest fleets of the civilized world, forms nearly two thirds of the entire distance of this proposed water communication. It has but one impediment to its navigation, arising from the present insufficient depth of water over the bars at its different mouths. Attention was first drawn by its remarkable powers, great dimensions, and favorable position to the great work contemplated. These very considerations, however, so far as any actual difficulties are to be overcome, cause it to become the least important and least interesting section. Certainly the most skeptical, as well as the most prejudiced opponent to the scheme must admit that in the event of a canal being successfully made to unite the waters of the Pacific and the Atrato, it will certainly be a matter of easy accomplishment for the engineering skill of the present day to devise some plan by means of which another and much shorter canal can be dug between the magnificent bed of the Atrato and the Gulf of Darien; one, also, of sufficient dimensions to float the largest sized vessels now in course of construction.

Immediately above the village of Boca de Sucio, the river Sucio, the tributary from which the name is derived, empties in on the right bank

of the Atrato. It is said to be of very considerable size and length, and several settlements of Indians are found along its banks. The Salaqui flows in directly opposite to it. This is but a caño, or arm, of the river Truandó, and separates from it at a point between four and five miles from its mouth. In that distance it courses through a swamp of coarse grammalote grass, with only here and there a group of trees of a peculiar species, called by the natives "Trementino." Where it enters the Atrato, its breadth was sixty feet, but in a short run of a a few miles, narrowed down at some places to twenty-five. Its depth of channel was twenty feet. Both width and depth seemed quite uniform. The velocity by log was a mile and a quarter per hour, but being a very tortuous stream, could not easily be arrived at. The apparent swiftness of the current, and the difficulty of rowing against it, seemed to indicate a much greater rate. In a very low stage the coarse grass almost conceals it from sight. This caño was entirely free from obstructions caused by fallen trees or drift wood.

A mile and a half above the mouth of the Salaqui, the Atrato receives from the west the waters of one of its largest adjuncts, the Truandó, through its principal caño, called by the natives Caño Cayman. The lower portion of the stream passes through a vast alluvial bottom, running nearly parallel to the main river, and at last joins it at a very acute angle. The flotilla of boats entered the latter through the Salaqui. On the return trip the hydrographic party descended by the the same one, whilst the party of engineers conducted the survey down the main caño, thus having the advantage of judging of the respective merits of each. The distance along the Truandó to the point of departure of the Salaqui, is a little over three miles. This section, like the Atrato, courses through a deep alluvial soil, and resembles in appearance the delta formation. There are several smaller outlets for its waters to escape into the Atrato. The banks are very low, and the roots of the trees exposed like the mangroves on the coast. The cause of this exposure is in effect similar to that of tidal action, the waters ebbing and flowing in unison with the rise and fall of the Atrato. The freshets of the latter dam up the Truandó, and force the stream to retire and fall back for many miles. A narrow bar is in consequence formed at the mouth. In width it is a hundred feet, a broad and beautiful stream, in comparison with which the Salaqui is a mere ditch. After crossing the bar, the depth is over thirty feet for more than a mile, and then gradually becomes less and less, until it averages about twenty throughout the section below the Salaqui. The trees along the river are very high, with good sized trunks. They are principally of one species, the Trementino, bearing a large poisonous nut. These the monkeys delighted to throw down at the boats passing along. The inner bark answers the purpose of thongs, and is used to tie and lash poles together. With the Atrato, one leaves behind the high winds which had proved so refreshing; the lower Truandó, pursuing its way through a dense swamp forest, feels not a single breath of air stealing over its surface. Long dark moss hangs suspended in gloomy festoons from the motionless branches, and reaching far out over the water, dresses nature in its most somber hues. The stillness of death reigns unbroken around. In order to present to the reader an exact

description of the route pursued, and of the varied incidents which occurred after leaving the Atrato, extracts will be made from notes daily taken whilst actually passing over the ground, showing the impressions made upon the mind at the time. In doing so there may be frequent repetitions, both as to the physical features of the country and its climatic character, but each subject will thereby receive more attention in detail.

The village of Boca de Sucio was reached early on the morning of the 16th December, and every one seemed gratified at the opportunity of once more landing on firm ground; all availed themselves of the opportunity of stretching their limbs after more than a week's confinement on board the boats.

Thursday, December 17, 1857.—This morning a start was made from the village for the mouth of the Salaqui. After several ineffectual efforts to bring the bogas down to their work, it being a time-honored custom of the natives to lie by for two or three days at each village along the river, in order to furnish an opportunity for a frolic, they were not pleased at any innovation in their established practices. During the greater part of the night a grand dance had been kept up by them, accompanied with singing and carousing upon rum and anisado. The wilds of the Atrato echoed long after midnight with their strange native melodies, all of a most plaintive character. After one unsuccessful trial to cross the river, in which the bungo was carelessly allowed to drop some distance below the village, a more labored effort on the part of the bogas, with the assistance of the whale boat, succeeded at length in bringing her safely into Salaqui. The boats had now left the highway of travel, and were fairly launched on their voyage of explorations.

After ascending for a few miles the Salaqui, of which mention has already been made, they anchored within a short distance of the point where it leaves the Truandó.

A canoe had been purchased at the village, and added to the flotilla. It proved useful in enabling the men to recover any chance game that was shot, and also in spearing fish. The day was cloudy, and the mean temperature 80° Fahr. Owing to the narrowness of the stream, the boats had to lay close to the grammalote grass, which proved a fruitful nest for mosquitoes.

December 18.—A slight rain fell during the night. Within a short time after starting, the main caño of the Truandó was entered. As the boats continued to pull up stream, the river became deeper and deeper. Both banks are still covered with heavy timber, bearing many beautiful varieties of parasites and mosses. There is but little undergrowth compared with the Atrato. But few palms appeared. To-day two of the old species were seen, and also one of the new, with a thorny trunk, from the roots upwards; the latter bore a nut, from which the palm oil is said to be made.

The stream continued beautiful, flowing with a deep, uniform current; the velocity of the latter was measured with the log at different points, and found to be, approximately, one and two tenths miles per hour; the general depth of the channel was over twenty feet; in width it was at first sixty feet, but afterwards ninety—seemingly growing

wider as the ascent was made. The reaches were all very long, many of them over a mile in length; the curves and bends all quite gentle. There were some few obstructions encountered from overhanging timber, and from trunks of fallen trees lying across the channel. The banks gradually became higher, and were about half a foot above the then stage of water, and appeared to be more solid. From high-water marks indicated on the trees, the greatest rise must be about four and a half feet above the level of the ground; within a few days the water appeared to have fallen nearly a foot. For many months in the year the whole country must be submerged, which accounts for the scanty growth of the higher orders of vegetation.

During the morning, in the midst of a brisk shower, a very small canoe passed down the stream, paddled by an Indian; a wife and child and dog were his only companions in the deep somber solitude of the place; they appeared to be independent of everybody and everything. A large wasp's nest, the dread of the bogas, being built on one of the fallen trees, was approached with great timidity. Both the wasps and hornets of the country are said to be very formidable; when disturbed, the whole nest make a general and ferocious attack. The naturalist of the party on one occasion fired the contents of a double-barreled gun into a nest, which entirely destroyed it and its occupants; the bogas, fearing the result, in a moment jumped overboard and took to the water. Different species of ants covered every leaf and branch—their large nests of mud presenting a singular appearance.

Myriads of harmless gnats thronged the boats; the white-winged fly, or congo, again made its appearance, stinging badly, but leaving no after irritation; mosquitoes of every known and unknown species still disturbed the stillness of night. Large fish were sporting in the waters, and huge alligators floated lazily along. Monkeys, turkeys, and many small birds were both seen and heard. The anchorage ground for the night was near the junction of two arms of the river.

A short time after stopping, a heavy tempest of wind commenced to blow, scattering the leaves in every direction. As the trees are generally very top-heavy, the branches seldom commencing to put out for many feet above the ground, and at the same time standing on a very unstable soil, it was somewhat frightful to contemplate one. The dread of a tree falling over the boats at any moment does not afford food for much quiet reflection. Shortly after the blow, a heavy rain began to fall, and continued until late in the evening.

December 19.—The sun rose bright and clear, and, with the exception of a passing shower in the afternoon, the day proved one of sunshine and smiles. The river was uniform in width and velocity; by several trials of the log, at distances of a mile or two apart, the rate proved to be about the same as yesterday; the average width has been seventy-five feet, and the depth of channel twenty. The general course was still northerly, nearly parallel to the Atrato. During the morning the different reaches were quite long, but in the afternoon the river began to be very tortuous, the bends still remaining well rounded, and not abrupt. The banks were firmer and a foot out of water. Several cleared places were passed, where still stood the but recently occupied huts of some migratory Indian families. At sun-

rise the temperature was 78°, and a short time before sunset 84°, scarcely any perceptible change during the day, and the nights only a shade cooler. Several black monkeys, some wood duck, and the first squirrel were killed, to be devoted to future analysis at the Smithsonian Institute.

The bungo presented a rare appearance, with its motley crowd of persons on deck, and the stanchions hung with the skins of different species of birds, monkeys, and other mammals, undergoing preparation to be packed away and sent home. The various tormenting insects still accompanied the party. Its path led not through pleasant places, nor was sleep courted on a bed of roses, notwithstanding the sweet perfume of flowers and the odor of aromatic woods still scent the entire atmosphere. The timber is becoming larger in cross section, and much higher, the foliage is very dense, and the vegetation possessed of the same characteristics as on the Upper Atrato.

December 20.—Not a member of the party enjoyed a wink of sleep during the night; a miserable, wretched state of mind, and a most feverish bodily feeling affected all the party. On the outside of the bars the musquitoes actually swarmed like bees; a mere touch would start myriads into the wildest commotion. Notwithstanding every precaution in tucking down the net, composed of the finest material, still many hundreds managed to get inside of it and make sad havoc upon poor weak nerves. Not a soul slept on board. At any moment of the night could be heard slap, slap, slap, as some hand came down in dire vengeance upon the ruthless tormenters. Think of being confined all day long in a sitting posture, not able even to stand up, and at sunset compelled to lay down and indulge in a wretched attempt at sleep for twelve hours, with those fierce insects infesting all surrounding space. Even that antidote and soporific whisky would not allay the irritation or bring sleep. Those on the bungo endeavored to pass away the heavy hours of the night by songs and the soothing influence of cigars. All hailed with pleasure the first break of day, when the light dispersed the cloud and drove the insects to their quiet and shady day retreats among the thick vegetation of the banks.

Whilst the boat weighed anchor and moved on, the usual glass of whisky was taken immediately after turning out from under the netting, in order to dispel any effects of lurking malaria. To this precaution, together with frequent bathing, can be attributed the almost uninterrupted good health of the parties during the ascent of the Atrato and Truandó. Certain precautionary measures will insure perfect exemptions from those evils which pervade all tropical climes.

During the greater part of the night it rained very hard, and continued to do so, more or less, for the balance of the day; the temperature varied between 77° and 79°. For the first mile the river preserved the sameness of yesterday; the section of the stream known by the natives as *Las Lagunas*, or the lakes, was then reached. The lower extremity of it is nearly eighteen miles from the Atrato, and it extends for a distance of four miles. Along this portion of the Truandó the stream, at the time of the ascent and on the return trip, ran between banks concealed by high grammalote grass; only here and there, at long intervals, a solitary tree is found standing as a lone sentinel to

mark the course of the water. During freshets the banks are said to be submerged, and the surrounding country then presents the appearance of a linked series of lakes or lagunas, or of a large lake dotted over with small islands, each covered with a stunted growth of trees. The prospect at such times has given rise to the name by which that peculiar portion of the river is known. The level of the lagunas is the extent of the overflows from the Atrato; at such times the whole surface lies almost entirely under water. The stage of the river at the time of the ascent was the mean or average one. The depth then varied from twelve to fifteen feet; from indications on the banks from some of the higher points it must be almost two feet more at the highest stage of water. The velocity of the current by frequent trials of the log was one and seven or eight tenths miles per hour. Owing to the openness of the adjacent country more extended views can be had of the mountain ranges, toward which the stream was gradually leading, than from any other point. Whilst passing through the lagunas on the first occasion a heavy fog palled the earth, and concealed them from the sight; when returning, however, a few months later the ranges extending along the Atrato and the one through which the Truandó breaks its way at the saltos or falls becomes distinctly visible. Shortly after passing the broad and open space of the lagunas the main body of the stream became considerably contracted. This diminution arose from the fact that the stream, instead of continuing its flow through a single large channel, had become divided up into several small ones, and these again subdivided, each leaving and returning at different intervals to the mother river. A perfect network of water courses thus formed, inclosing within their embrace clusters of islands of greater or less dimensions. The main channel had narrowed down to about forty feet, growing by degrees more and more tortuous. The banks began to be somewhat higher, and seemed possessed of more consistency than along the lower part of the river. In consequence of the reaches becoming so much shorter, and the bends more abrupt, it was with considerable trouble the bogas managed to navigate the barquetona. The timber also became larger and more dense, and the undergrowth very compact. The commencement of other difficulties seriously impeded the progress of the boats; snags, sawyers, and overhanging branches frequently interposed many obstacles in their way, whilst in many instances large trees had fallen immediately across the stream, and until removed forbid further progress. These barriers and obstacles even in high water constitute impediments to the navigation of the river, save with the long narrow canoe; the latter, too, meet with many hindrances when the river falls below its usual state. The portion of the Truandó just described proved to be the entrance to the section of the river called by the natives *Las Palizadas*. These words have the same signification as the English ones the *palisades*. Throughout its whole length obstructions are constantly encountered. These in the main consist of those artificial fences or rafts formed by fallen trees catching immense quantities of drift-wood which have been floated down during the high freshets; all become fastened together in one inseparable mass. The imbedded trunks form the nuclei around and upon which deposits of earthy matter are made, creating additional

islands. These perform their part in dividing the stream into new channels, many of them narrow and intricate. Until the palizadas were reached but few difficulties were encountered in the bed of the stream. Compelled from the great depth of water to pole against the overhanging limbs, thick grass, and heavy undergrowth, the bogas managed to work very well, and the bungo made considerable headway. Fortunately, after entering them the channel became deep, and the palancas were able to touch the bottom, so that some little progress could be made against the now fast increasing velocity of the current. It was an impossibility to measure the latter or approximate in any way to the truth of its strength, owing to all absence of uniformity in the bed of the stream, the numerous channels into which it was divided, and the constant interruptions to a regular, even flow. All heights of points determined by hydraulic calculations based upon actual measurements in a stream like the Truandó must necessarily be very incorrect. The formula for computing problems of this kind are deduced from experiments made under the most favorable circumstances. By means of the canoe the macheteros could paddle close up to any obstructions, and after cutting them up into pieces of four or five feet in length float them away.

The bogas, too, without fear of alligators, would jump into the stream, fasten on to a snag, and soon drag it out from its fastenings. They seemed to be amphibious, apparently working better in the water than out of it. But very little distance was made to-day. The course of the stream began to change late in the day, and became more easterly. Since leaving the Atrato it has been running a little east of north, very nearly parallel, and not far distant from that river. Owing to the rain but few birds were seen, some roaring monkeys were heard, and the call of the turkey was detected. The swiftness of the current accounted for the absence of alligators. Scorpions and lizards have appeared. A magnificent blue butterfly was seen playing about for the first time to-day; its deep rich color surpassed any before seen; the play of light upon its wings was superb. Still the same profusion of rich undergrowth. Many new floral varieties are constantly met.

December 21.—Having anchored in fast running water, and away from the grammalote grass, the mosquitoes did not molest the party much during the night.

The rain continued to fall for a short time during the night; the greater part of the day was, however, pleasant, the sun occasionally deigning to shine. An extremely heavy shower fell for an hour during the afternoon. In every respect the nature of the river is but a repetition of yesterday. During the whole day the barquetona had to be warped along with lines, the canoe proving of good service in paying them out. Only a short distance was made.

The reaches were not long, but the bends were regular, the depth varied from ten to fifteen feet, and the width was about seventy. The vegetation is very much the same. Above the Lagunas the Trementino disappeared, and most of the monkeys with it. The trees had now become very straight and high, covered with a bright green foliage and many beautiful parasitic plants; heavy vines still festooned them

from their very tops. The belt of timber appeared to become greater in width, and indicated a near approach to terra firma along the mountain slopes. A freshet in the river to-day submerged the banks at several points. Several huts were passed. After a great deal of labor and but very little distance made, the boats finally anchored for the night at the lower extremity of an island dividing the principal channel into two equally large ones. The day had cleared up delightfully, and shortly after sunset the moon shone forth beautifully bright.

December 22.—A pleasant day followed a most charming night; the atmosphere was most refreshing. The river underwent but few changes until towards the close of the day. Then a net-work of small islands were encountered, dividing it into several channels, making the ascent by either difficult and circuitous. The Truandó, throughout the Palizadas, is a wild mountain stream, boldly coursing along between banks lined with the richest growth and foliage. Graceful vines still reached from limb to limb, and not unfrequently stretched across the stream in rich clusters of leaves and flowers interwoven and plaited together.

Owing to the still numerous difficulties to contend against on account of overhanging and sunken trees, but little progress was made throughout the day. The head of barquetona navigation could not be far in advance.

December 23.—An advance party, consisting of the whale boat and two life boats, started this morning to seek for the first spot favorable for a camp and temporary depot, it being evident the large one could not ascend much higher. In reality, after proceeding but a short distance, large trees spanning the river, and other obstacles were encountered. Every ax had to be brought into requisition, and great exertions made to open a channel. This continued to be the case along every reach, the logs and fallen timber becoming more and more frequent. Then followed another succession of small islands, which again cut the river into numerous divisions, narrow, tortuous, and swift, and filled with snags, and sawyers, and drift. Owing to the many currents and counter-currents the boats became difficult to control, and at times almost unmanageable. At noon, but a very short distance having been made, even by the smaller craft, it was deemed necessary to land, and, for the first time since leaving the gulf, establish a camp on *terra firma*. This last term was not strictly applicable to the condition of the soil, as after experience proved it to be of a semi-fluid consistency.

It had been a cherished hope, from representations made by the inhabitants at Boca de Sucio, that the barquetona could be carried up the Truandó as high as the Saltos, or falls, where a permanent depot might be safely established. In consequence of the many difficulties already experienced, and the probability of many more existing ahead, it was thought advisable to abandon any such idea. At the point of landing the banks were vertical, and about four feet above the stage of water at the time. The river made a clean cut between them, and was almost as deep on each side as in the center. There were many indications of overflow, and the locality would therefore be useful only as a temporary place of deposit; thence supplies, camp equipage, and

instruments could be forwarded to the Saltos by means of the small boats and canoes. As soon as landed, the party commenced making a clearing, the trees being large and growing close together, and the undergrowth very thick. Some hours were employed in felling a space of a hundred feet square to enable the rays of the sun to reach the humid soil and allow the air to circulate more freely. Great trouble and annoyance were experienced in consequence of the miserable quality of the axes which had been furnished the expedition. They proved almost worthless. The native macheteros in a short time built a shed, or *rancho*, as it is called in the language of the country. It consisted simply of four posts for corners, with poles for sleepers, ties and rafters, and thatched with the broad leaves of the palm.

No nails, or strings, or ropes were used, substitutes for them being found in the numerous vines hanging in tangled masses from the branches, or spread over the ground. The unusual exercise during the day tired all, and although it was a luxury not to be compelled to go to bed with the sun, still few availed themselves of the pleasure of remaining up after dark.

December 24.—The fatigue of yesterday brought with it sound sleep. The men swung their hammocks in the rancho, and the officers still occupied the boats. In the morning one of the life boats was sent back to communicate with the bungo, and found that she had only made a few thousand feet the day before: the bogas, however, continued to warp her slowly up stream. A walk along the bank of the river proved so difficult, being compelled to cut every inch of the way with machetes through thick undergrowth of every imaginable species, that it was decided at once to make the survey in boats. It would be impossible, without great labor and loss of time, to accomplish it on land.

The whole surface of the ground, too, seemed covered with numberless varieties of ants, all busy in their labors. It was with great difficulty that one could keep free from their annoying stings and bites. Tracks of the peccary and tapir were found near camp. Notwithstanding the great distance from civilized parts of the world, and the many surrounding discomforts, Christmas eve was nevertheless duly celebrated in the swamps and wilderness of the province of Chocó.

December 25.—It rained very slightly during the night. Owing to the compactness of growth of the forest trees in this swamp region, their limbs do not branch out for many feet above the ground; and at the same time, being generally very high, they necessarily become quite top heavy. The size of the roots, also, is not in proportion to the dimensions of the trunk, nor can they be very deeply imbedded in a soil which but a few feet below the surface is in a semi-fluid state. They are partially sustained and mutually supported by their respective branches being interwoven together with connecting vines. When the leaves become saturated by rain, the weight increases very much, and they are in many cases either blown down by the winds or fall by the force of gravity alone. During the night a small one fell across the stern of the whale boat, breaking the ridge pole of the awning, but injuring no one. The news from the Concha was not very satisfactory, she having ascended only between one and two thousand feet during

the whole of yesterday. As it would be impossible to bring her up to the camp, arrangements were made to discharge the load. The river, too, was falling rapidly, and the greater the necessity therefore of unloading her, that she might turn back. Some tents were pitched to-day, and the slightly perceptible air of comfort presented by them made camp look more pleasant. No very cheerful faces were visible, the thoughts of all being seemingly of home on this great holiday. Although deprived of the delicate viands which graced the festive boards of many a home on this day of general rejoicing, still none seemed wanting in good appetites to enjoy the pork and beans and plantains, which constituted a Christmas repast on the banks of the Truandó.

December 26.—This morning the life-boats were sent down to discharge the barquetona, and by noon, after several return trips had been made by each, all the freight, consisting of instruments, provisions, camp equipage, arms, and ammunition, were landed in camp and stowed away under temporary shelter. But a single accident occurred: during the last trip, one of the boats, having been badly loaded, was upset, and both men and cargo thrown into the river. Fortunately the canoe was near at hand, and succeeded in picking up most of the floating articles. The effects of the geologist and naturalist of the expedition were on board. All were recovered save a pouch containing his notes, the loss of which proved very serious to him. They were very full upon the subject of natural history and botany, and contained sketches of views about Cartajena and along the Atrato; also, drawings of animals, flowers, fruit, and nuts. This was an early lesson for every one to render all notes in duplicate, especially while traversing a region in which there is so much liability to accident at almost any moment. Among the sunken articles were the navy carbines for the use of the expedition. So far as their intrinsic value was concerned, and their peculiar fitness for the service which they were intended to render, being perfectly useless in a moist climate, it would have been perhaps better to let them lay in the bottom of the stream than to be troubled with their transportation. One of the bogas an excellent diver, however, recovered them all. As the river continued falling rapidly, the patron of the Concha urged her immediate departure on being unloaded. Accordingly, in the evening, with only her crew, she dropped down stream, and in three days expected to reach the Gulf of Darien. Her return from Cartajena was looked for early in February. It was designed that she should meet the parties with additional supplies on their way back from the Pacific. The prayers of many accompanied her, and all wished her a safe and speedy trip. The hopes of a complete and successful termination of the objects of the expedition depended greatly upon the Concha's reappearance. After all the trouble experienced in ascending the Truandó to this point, any person will readily admit the great advantage that would have been gained, both in time and labor, by the employment of the largest sized canoes, instead of attempting to use the barquetona and whale boat. Four or five of them would have transported everything in a few trips, to some well selected dry point above, with very little if any difficulty.

After the departure of the Concha, the camp presented quite an

animated appearance. Some were occupied in erecting ranchos to shelter them from rains, and protect them from the heavy damp night air, whilst others were overhauling their effects, examining instruments, and making preparations for the work before them. The time for actual labors having arrived, the two officers of the Navy and Army—the former in charge of the hydrographic and the latter of the engineering party, both of whom had been directed by joint instructions to coöperate in their movements—discussed at some length the place of future operations. The first concluded to push on slowly with his party, taking with him the whale boat and one life-boat, and whilst opening the channel to transport the main bulk of the provisions up to the Saltos, and at that point establish a main depot of supplies, afterwards to proceed across the mountains to the Pacific, and there make a hydrographic survey of the harbor at the western terminus of the proposed canal. This arrangement was considerably changed, as will subsequently appear. The officer in charge of the party of engineers determined to commence at once with the topographical survey of the canal route, working gradually up the Truandó, Nercua, and Hingadór, and then across the Cordilleras de los Andes to the ocean. On returning, to resume the survey at the initial point, and conduct it down the Truandó to the Atrato, and then by the latter river to the Gulf of Darien, afterwards to connect it with the hydrographic survey already going forward under the immediate direction of Lieutenant Bradford, of the Navy, who had been left behind for that purpose in charge of the schooner Varina. One life-boat and one canoe were the only means of transportation available at the time for conducting the survey; two small flat-boats were built by the ship's carpenter, but proved of little service in a stream like the Truandó. An attempt was made to use them as transports for a few miles, but then only by towing them astern of the life-boat. At a subsequent period great assistance was rendered by the Chocó Indians with their canoes, and the survey was conducted under more auspicious circumstances.

December 27.—Issues of provisions were made to-day by the officer of the Navy—the acting purser of the expedition—to the respective parties as they were about to separate, each to perform its own special duty. Both were provisioned for four weeks. It was expected that by the end of that time the work would have progressed sufficiently far to bring each within a convenient distance of the main depot, where supplies could be renewed.

Although the expedition should not have left the schooner Varina without full rations for at least three months, and that was the understanding between the officers, still, owing to a deficit of several of the most essential articles, discovered, however, when too late, each ration was very considerably reduced in quantity at the very first issue; neither was there left on hand a sufficiency of many articles for a second issue of the same length of time, even at the reduced rate. In the first place, the schooner Varina, upon which several thousand dollars of the very small appropriation for the survey had been expended in repairs, was scarcely large enough to transport the members alone of the two parties to the gulf, much less to carry, in addi-

tion, even from the nearest port, a sufficient amount of provisions for their support during a prolonged absence of four or five months.

Nor were the dimensions of the barquetona sufficiently ample, even with the assistance of the other boats, to convey the field parties and the necessary supplies for the length of time required to make the survey.

From the very start of the expedition, the amount of transportation was too limited. Whilst engaged in issuing rations, some Chocó Indians arrived, and added a little variety to the events of the day; they encamped on the opposite bank.

The head of the family, bearing the Christian name of Juan, stated that he could go to his home on the Nercua and back in three days, traveling the entire distance in his canoe. From his home he could walk across the mountains to the Pacific in one day. They supplied the parties with fish, which were skillfully caught with hook and line; some specimens were preserved for future examination. The day proved warm and cheerful, and the evening pleasant. The atmosphere has generally been cool and very uniform in temperature. The evening was passed around the camp fires. Congoes and gnats continued still to annoy by day, and mosquitoes by night.

December 28.—This morning dawned bright and fair. The hydrographic party made a start to-day, but, having encountered several difficulties, returned to camp.

Additional tents were pitched.

All hands prepared to sleep on land. Some swung their hammocks, whilst others made their beds on planks laid on the ground. The natives built platforms with poles, several feet above ground, upon which they slept; the smoke of a slow fire, made beneath them, drove away the mosquitoes. Four white faced monkeys were shot and a nest of alligator's eggs found, so that camp luxuriated upon the feast afforded them. In the evening it rained slightly.

December 29.—The hydrographic party again made a start this morning, and with better success than yesterday. It consisted of the officer of the navy in charge; the guide; three third class assistants; two sailors from the schooner; five native macheteros, and one cook. The surgeon of the expedition and the ship's carpenter were also attached to it. The party of engineers was composed of the officer of topographical engineers in charge; the geologist and naturalist; one principal surveyor; one surveyor and draughtsman; one computer; one assistant surveyor; one meteorologist; six third class assistants, as rodmen and instrument bearers; two natives, as boatmen, and two cooks. The hospital steward was also attached to this party. The great feature of the day was the commencement of the survey of the interoceanic ship canal route. This work comprised the running of a line of spirit levels from the Atrato, across the mountains, to the Pacific, so as to be able to furnish the material for a correct and accurate profile; also, in the consequent measurement of distances and magnetic readings of courses, and in making such drawings and examinations of the topographical features of the country so as, at some future time, to delineate them properly on maps.

A series of astronomical and meteorological observations were also commenced, and the varying phenomena of the Truandó noted.

The instruments used and the manner of conducting these scientific labors form subject-matter for another chapter.

Collections in botany and natural history continued to be still unceasingly made, although every gleam of sunshine had to be employed in drying the specimens, to prevent them from spoiling. The grunting of wild hogs and the cry of cats were heard about camp to-day. Several articles having been found deficient, both in numbers and in quality, such as axes and machets, and being indispensable, the Chocó Indian Juan was dispatched to Boca de Sucio to obtain them, promising to return in three days. The survey made but little progress during the day, owing to the denseness of the undergrowth and the tortuous nature of the river.

December 30.—The running of the line of levels was continued, but not very rapidly; the atmosphere, being very hazy and murky, caused the glasses of the instruments to become so covered with moisture as almost to prevent the possibility of using them.

December 31.—Until far in the afternoon the day was beautiful; the sun shone brightly and the survey made good progress; in consequence all returned to camp better satisfied. The Truando was still found to be very tortuous and narrow; the small islands, which divided its waters into numerous and intricate channels, made the operations along it slow and difficult. Juan, the Indian, returned to-day with the articles ordered from Boca de Sucio.

Shortly after the close of the day's labors, heavy lowering clouds began to darken all surrounding space, the lightning was seen to play in the distance, and the deep muttering of thunder was heard. In a very few moments the storm broke over camp in all its violence; the rain poured down in torrents, and for an hour fell without intermission. The rain gauge measured one and seven tenths of an inch in that time.

The whole camp was flooded with water. Although an overflow was anticipated, still the river did not commence to rise until after dark, and then but slowly. Several large sluices which ran back of the clearing served as efficacious drains; the usually semi-fluid soil became completely saturated, and made it necessary for all to wade through mud nearly up to their knees. Some of the ranchos had to be deserted, and, notwithstanding the tents proved impervious to the falling rain, still streams of water flowed through them, much to the discomfort of the inmates. All the fires were extinguished save one, and around this the different members of the party gathered, standing in several inches of mud, to pass away the most dismal new year's eve ever experienced by any one of them. The Truandó, as it courses along between the most dense and impenetrable forest outlines, seemed to flow away into regions of utter darkness; and, as it gradually rose higher and higher in the gloom of that black and awful night, threatening to submerge the whole surrounding country, one could scarce suppress the thought that it might in its strength sweep away the whole camp, and thus compel the abandonment of a great work, upon

which all had concentrated their energies, in hope of future reputation.

A careful night watch was kept over the river.

January 1, 1858.—At an early hour the stream was found to have risen to within six inches of the level of the camp, and still rising. All hands were called to load the life boat with provisions and such articles as were absolutely necessary; also to place the instruments and camp equippage for safety upon a platform of logs and fallen trees raised some few feet above the ground. All expected to take to the boats. Although there was not a doubt in the mind of any one that the river would overflow its banks, still, from the flat and swampy nature of the country, no one imagined it could rise much above the general level of the soil. The only dread anticipated was that, by some freak of nature, it might force for itself some new passage, and perhaps one directly through the camp. This was not entirely an ungrounded fear, for very frequently rivers cut new channels for themselves through alluvial soil. The rain had ceased; three tenths of an inch had fallen during the night, making two inches in all. Soon after daylight, however, all surmise ceased; for the river, after continuing to rise until it reached the same level with the surface of the ground, and even at some low places entirely inundating the banks, commenced to fall. The presumption was that such would be the case in all subsequent freshets. Owing to the extreme moisture of the climate, it was found difficult to keep matches sufficiently dry for use at any time, and more particularly so on such an occasion. It was only after much patience that a fire could be kindled from the only solitary live coal found in camp for the purpose of preparing breakfast. The day subsequently cleared up beautifully bright, and notwithstanding the wet, muddy condition of camp, and the fears of the past night, all celebrated the occasion with spirit, the narrow escape causing a general rejoicing.

January 2 *to January* 9.—During this interval of time the party of engineers remained encamped at the same place. The survey was continued daily, save when interrupted by unavoidable causes, and at all times under the greatest disadvantages. During the ten days that the party was able to work it had reached the Indian village of Tocome, nearly three miles above, and had also been carried down stream about two miles, to a point a short distance below the head of bungo navigation. The progress along this section of the Palizadas was extremely slow, but could not be hastened. The sinuosities of the river had to be followed in all their tortuous wanderings; continuous felling of trees and clearing away of undergrowth, to obtain clear lines of sight caused great delay. Frequent rains and freshets suspended, temporarily, all operations; and the defficiency of transportation occasioned frequent interruptions in the work. Astronomical and meteorological observations were daily continued. The tremulous condition of the ground, however, and the varying atmospheric changes often interfered with the former. On the afternoon of the 3d instant it commenced to rain, and continued to do so all night. The sum total of the fall was one and three tenths inches. The river again rose even with the banks, and remained up for several hours; for a short time the water ran through camp in a perfect stream. During the night of the 5th it also rained

very hard, but only for a few hours. In consequence of the increased gravity of the upper limbs caused by these rains many trees fell. They usually came down with great force, causing the forest to resound with the noise of the crash, the echo reverberating far and wide, and reaching its innermost depths. Day and night the sounds could be heard proceeding from every direction. A large one fell in camp at night, and considerably startled those sleeping near it, but without doing any injury. Although not one of the highest, still it measured one hundred and twenty feet in length. There were several stories of plants along its trunk; here one kind of parasite and a few feet higher up one of some other species. These different stories corresponded to the various atmospheric strata; the more elevated above the ground the more dry and light they become. A small caoutchouc or Indian-rubber tree was cut down, and specimens of the sap, wood, and leaves procured from it. On the morning of the 7th commenced moving camp to the Indian village above. For this purpose the canoe was alone available, it not being deemed advisable to interrupt the survey by using the life-boat. Notwithstanding the boat could not be loaded very high above the water, and being manned by inexpert hands, still it carried over a thousand pounds, and reached its destination in four hours. The hydrographic party had left the place only an hour before. On the 8th, notwithstanding the rain came down in torrents during a great part of the morning, the moving continued. The life-boat, towing astern one of the flatboats, and the canoe were employed on this occasion. They returned in the evening.

Final preparations were made to transport the balance of the camp effects early on the following day. In labeling and packing away for shipment specimens of natural history already collected, it was found that they numbered a hundred and fifty different species, and over three hundred specimens. Two new species of marmosets of the monkey kind were among them.

January 9.—The party turned out at daylight, and struck the tents. The remaining instruments and provisions were then loaded in three boats—the life-boat, the canoe, and the remaining flatboat.

After breakfasting heartily on the marmosets, a start was made for the new camp at Tocome. No one regretted leaving the old one, as all had there experienced a most miserable time. The first part of the river between the two proved very tortuous, and in width not more than twenty feet. It was more a matter of surprise how a survey could ever have been made of it, than that so much time should be taken to execute it. None of the party had ever experienced more difficulty on similar works. Narrow, with many obstructions from rafts and overhanging timber, and running with a swift current, the life-boat did not average a mile an hour in the ascent. The river was found to be falling very fast, and appeared much lower than at any previous time during the work; the banks had also become much higher. The labor previously performed by the hydrographic party in removing obstructions from the channel, did not now prove of much advantage. The second part of the stream between the two camps was much wider and less difficult to navigate, save one short stretch of only ten feet in breadth. Better progress was then made. The

life-boat was poled along by the natives, it being impossible to use the oars, and the flat scow was towed astern of her.

Many beautiful trees were seen; among them many varieties of the palm, gracefully bending to the breeze. Several new ferns were collected; also many flowers, which would have richly ornamented any conservatory, and been highly cherished for their exotic qualities. When near the village a clearing was passed, where the Indians grow sugar cane and plantains; one of the latter plants was in full blossom. At the same time a canoe from Boca de Sucio came up loaded with their delicious fruit, and bound for camp; it had only taken parts of three days to make the journey. About an hour after noon Tocome was reached; the village consisted of only one house, intended, however, for several families; it stands near the bank of the river, about half an acre of ground having been cleared around it. It was built, like those at Sucio and Turbo, on piles several feet above the ground, to avoid dampness and snakes; the sides and flooring were of cane, and the roof was thatched with palm; a single notched log forming the steps by which to ascend to the entrance or door. This is the first locality on the Truandó at which there is a permanent abode; by spirit level it is 55.45 feet above the mean level of the sea, and 29.72 feet above the village of Boca de Sucio; from this fact, and for the reason that the first fields are here found where corn, sugar cane, plantains, and bananas have been cultivated, it is more than probable that the river very seldom inundates its banks at this point. Although vegetable growth is very rapid, still the Indians could not plant with any degree of certainty should their lands be subject to frequent overflows; they are too poor to run any such risk. Although but a very short distance in a direct line above the first camp, still the severe rain at the latter place had not been felt the day before; the banks were seven feet high by measurement. The party, upon arriving at the village, learned that some alterations had taken place in the plans of the hydrographic corps. Finding it impossible to take the whale boat further, a depot had been established there and placed under the care of the ship's carpenter. The officer in charge had left behind information regarding the change. It appeared that, in order to expedite his movements, he had only taken with him absolute necessities in the way of provisions, with the intention of pushing on as fast as possible towards the Pacific, and after completing the reconnoissance of the harbor on that coast, to return immediately to the Gulf of Darien. To accomplish this, he had engaged the services of the only Indian at Tocome, and, with the aid of two canoes and his life-boat, had hastened forward. In order to be able to move rapidly, he had only taken with him a sextant, some pocket chronometers, and a boat compass, with which to make his hydrographic surveys. His party consisted of the doctor, three third class assistants, the guide, two sailors, five natives, and two Indians. This arrangement placed the party of engineers in a great dilemma as to the mode of transporting the supplies needed by them to make a complete and continuous survey across. The understanding was that the advance should carry the bulk of them as far as the Saltos, as the latter had no work to accomplish until the Pacific coast was reached. The life-boat and canoe now only remained to the

former, and the supply of transportation in consequence was very limited. During the afternoon a most welcome messenger arrived in a small canoe from Boca de Sucio, a little over a day *en route;* he was the bearer of letters forwarded to that place by the consul at Cartajena, the first which had been received since leaving there. Observations were made at night with the sextant and chronometer; owing to the great moisture of the climate dew quickly deposited on the glasses of the instruments, and made it difficult and trying work; fleeting clouds would constantly interrupt the series by concealing the stars from vision, whilst mosquitoes interfered by attacking most unmercifully both face and hands of the observer. Many of the party occupied the house, or tambo, as it is called by the Indians, whilst others pitched their tents.

January 10.—Early this morning the expressman of yesterday started on his way back, carrying with him such letters as had been hastily written. This would probably be the last opportunity of writing until the return of the party. The survey of the river was continued to-day. During the afternoon all hands were rejoiced by the arrival of a Chocó Indian and his family; the *pater familias* was named Jesus Maria. After the first appeared, several others came drifting down the stream in their light canoes. Among the latter was a blind man; standing in the bow of his canoe, and paddling always on the same side, he balanced himself perfectly, and shared the labors of transporting his children and effects; his wife, seated in the stern, guided it cautiously and safely along its course. Altogether there were sixteen in number—three men, four women, five boys, and the rest young children. They insisted upon those of the party who had occupied their house to continue to do so. To show their hospitality and kindness of heart, they proffered to their guests corn dodgers, baked in palm leaves, and also dried fish; occasionally, too, they indulged them with some of their intoxicating drinks—one made from honey and another distilled from corn. One of their principal articles of food is fish, dried and smoked for preservation; they are exceedingly expert fishermen. With their long blow-guns, they shoot the pavo, or turkey, of the country, and the iguano; and, with their spears, dispatch the peccary, or wild hog. The eggs of the alligator are also eaten whenever found; corn and platanos, however, form the main staple of supply. Their dress is very simple; the men wear a narrow strip of muslin, or calico, between the legs, the ends held up by a cord tied about the hips; the women wrap a larger piece around the body to screen the middle of the person, and the children go about as naked as nature made them.

The Chocós are not tall nor remarkable in appearance, but always look well conditioned. They are very active, and manage the canoe with great skill. The hair drops naturally down from the head; the few front locks are cut short, in order not to interfere with the sight. Little paint is used among them; but, like all their race, they are fond of ornaments made of glass beads. They are quite cleanly, frequently bathing during the day. The women do all the work at home, whilst the men fish and labor in the field. The former load and un-

load the canoes during a journey, but both sexes assist in managing them. Their life is a migratory one, passing backwards and forwards between their tambos. Occasionally they make visits to the Pacific for cocoa nuts, from the shells of which they make cups and spoons; and at other times take a trip to Boca de Sucio for pleasure and trade. The arrival of these Indians was entirely unanticipated, and their presence assisted in removing many of the greatest difficulties which had been staring the party in the face. They were seemingly very kindly disposed, and arrangements were soon made with them to transport provisions and instruments and all things not actually needed by the surveying party up to the Saltos. When traveling about they carry with them a species of cloth, made of unprepared caoutchouc, upon which they sleep; a rancho of palm leaves shelters them from exposure to rain. They light their dwellings and camps at night by torches of palm wood, dipped in a mixture of palm oil and wax. Their habits seemed to be very sociable. During one of the nights passed among them they indulged in a wild orgie from having taken too much of their distilled liquor. Quarrels and fights took place in consequence, but Don Jesus Maria, with all the dignity of his office as alcalde, generally interfered to prevent their repetition.

A second issue of rations was made to-day for an additional period of four weeks to what remained on hand from the first; although at reduced rates, still many of the most necessary articles were wanting, such as sugar, coffee, and rice.

January 11.—This morning all save the members of the surveying party packed up to be in readiness to start for the falls. At the last moment it was discovered that old Don Jesus Maria had left home early to look after his corn, and would not be back until late in the day. The others were busy in cutting and seasoning over a slow fire, the poles or palancas to be used in the ascent of the river.

The survey progressed slowly, and had already reached a point some little distance above Tocome. The river was falling gradually, and each day becoming more favorable for conducting the work. Several more Indians had in the mean time arrived. They completely filled the house. The three original races, whites, Indians and negroes, from twenty-five to thirty souls, slept under one roof. Two of the party were lost to-day for several hours; owing to the great denseness of the timber, it is difficult to find one's way through it, even when using the greatest precaution. Several gun shots guided them back to camp.

January 12.—The old chieftain, being ready to start this morning, pointed out three canoes, which, in addition to the one belonging to the party, were to act as transports. The Indians did not pretend to offer any assistance in loading them, but when ready paddled out into the middle of the stream to try if they were well balanced, and, after some alterations in the loads, expressed their willingness to proceed. The largest one was managed by two full grown men; two of the others each by two boys; and the third by the cook of the party, who had become quite skillful in the use of the paddle. The main bulk of the provisions, the astronomical instruments, and the camp equipage, had first to be sent forward. Accompanying them were the officer in

charge, the naturalist and geologist, the meteorologist, and the computer. The remainder of the party werep laced more immediately under the direction of the principal surveyor, who had directions to continue daily the survey up stream. The large canoe was twenty-five feet long by two wide. Its load consisted of one large packing box, containing a portable astronomical transit; two others with zenith telescope and stand; one sextant; one basket of chronometers; one canteen for natural history specimens; one keg of whisky; and one carpet bag. Besides the articles enumerated, there were sundry others, including cooking utensils, lamps, axes, machetes, guns, &c., and last, though not least, three men. The smaller canoes were loaded proportionally. The labor of impelling them forward seemed mostly to fall upon the Indians stationed at the bows. For this purpose they used poles, or palancas, long poles of tough wood, which had been previously seasoned by holding them over a hot fire. Crotchets are made near the ends by neatly tying to each, with strips of bark, small additional pieces, either cut or bent into a curved form. The point is used when the bottom can be readily reached, whilst the crotch serves to catch and hold in its angle the limbs of overhanging trees, which act as a substitute to pole against in case of too great depth of water. A few feet are left clear near the bow of the canoe to furnish space for the poleman to walk after setting his palanca. The wonder to the uninitiated is that the boat does not upset; as he carelessly moves backwards and forwards, it is really astonishing with what ease he balances himself. A second Indian, either man or woman, occupies the stern, and guides the canoe by means of a paddle, scarcely any perceptible motion being given to it. In very dangerous places, however, the palanca is used instead of the paddle.

The first portion of the river, for nearly a mile above the village, is of the same character as the Palizadas below, narrow, rapid, and filled with obstructions. Several places were difficult to pass, and, at the low stage of water then existing, many logs had to be cut away or the canoes dragged over them. The width was about thirty feet in the main channel, the latter varying in depth. A fair estimate of the quantity of water supplied by the stream could not possibly be made. The canoes then left the principal bed, and followed, for a short distance, a narrow chûte of only eight or ten feet in breadth. By so doing, they were enabled to pass around a large raft which stretched across the river. Above it lay a magnificent and beautiful sheet of water. The width had become from ninety to a hundred yards, and the channel very deep. The banks, too, had grown higher and higher, and were already twenty feet above the surface of the water. The dimensions of the Truandó had suddenly grown grand and imposing. The canoes glided quietly along on its calm surface in strong contrast to their previous labored efforts. Every one seemed to breathe new hopes and inspirations. For two miles and a half the ascent had continued uninterruptedly, when a second huge raft of drift timber was encountered, which reached from bank to bank, and again dammed up the waters of the river. This was avoided by ascending a very narrow tortuous arm which ran with a rapid current to the right of it. In a half mile the main river again spread out in all its beauty, and the

happy information was received from the Indians that the head of the Palizadas had been gained at last. The immense piles of drift forming the raft presented from above an imposing obstacle. For ages this work of imbedded masses of timber have been slowly going on, and had now grown into formidable dimensions. During high water the fall over this artificial dam must be grand and terrific. The river at the time, however, had become so low as to expose low sand points at each bend, and these very materially assisted the progress of the survey. Much of the labor of clearing and cutting away the undergrowth and overhanging limbs could be dispensed with. The running of a line of levels through the Palizadas was exceedingly arduous and troublesome. As the ascent was continued, the broad bed of the stream, flowing along in graceful curves, presented beautiful stretches of scenery. The rich alluvial banks were covered with variegated shrubbery, and the waters were shaded by the thick green foliage of lofty trees.

Four and a half miles above the raft a shingle beach was reached, where for the first time gravel stones appeared on the surface. As this spot was a favorite stopping place for the Indians, a midway camp between Tocome and the Saltos, the canoes were hauled upon shore for the night. The one containing the computer and paddled by the cook had also fallen behind, and it was deemed advisable to wait for her. The fires of the hydrographic party, which had encamped at the same place, were still burning, showing that a forward movement had been made but a few hours before. Although a host of sand flies welcomed the arrival of the canoes, still the occupants were glad to be freed from the quiet and cramped positions so long held by them. In the absence of the cook, all hands had to take part in preparing dinner. An experiment was made upon the eggs of the alligator, which the Indian boys dug out of holes in the sand. When fried with pork they were found very palatable. The natives preferred to boil them; they, together with some fish and corn cakes, constituted their meal. All awaited anxiously for the missing canoe, but not appearing by dark, it was finally concluded that she must have returned to Tocome. With the set of sun the sand flies disappeared, and for the first time the party became free from any molestation by musquitoes. This camp appeared to be above their sphere of action. The night proved delightful; the atmosphere was cool and refreshing, but no covering was needed. The stars again shone forth brilliant and clear. The distance made above Tocome was nine miles.

January 13.—Soon after sunrise the canoes were again on their way. Although nothing had been heard of the missing one, still no fears were felt on her account, as the surveying party was known to be near at hand in the event of an accident. The Truandó, now confined to one bed, flowed along in quiet solitude, and for some distance continued to present the same beautiful appearance which it possessed during the last few miles of the day previous. It coursed its way through a rich, deep soil of table land, covered by immense trees and a profuse vegetation of shrubs. The width was from ninety to a hundred feet, and the depth in the channel over ten, so that the canoes had to skirt along the banks in order to use the palancas against the

overhanging limbs. After ascending four miles the mouth of the Rio Salado was reached. Opposite to it lays a small island inhabited solely by alligators. They stretch themselves out on the sand and bask in the warm rays of the sun. On the bank was a deserted rancho used by the natives when engaged in searching for caoutchouc. A short distance above the Salado, several small islands covered with gravel and quartz stones were encountered. The river there widened out, and the channel became low with a swift current, so that the canoes had to be forced up the rapids by hand. Previous to lunching, some of the party indulged in a bath, the temperature of the water being 77° Fahrenheit. Bathing in the stream had become a daily luxury after the establishment of the first camp, and proved not only extremely refreshing but also very salutary. The temperature of the atmosphere now varied but little; during both day and night it ranged from 75° to 80° Fahrenheit. The night dews still continued very heavy. Growing wilder and more romantic in its character, the stream indicated by its appearance and its increased velocity a near approach to some mountain range, although none had yet become visible to the sight. The dense timber and the high banks, at some points twenty-five feet above the surface of the water, forbid any very extended vision. After passing the lower series of rapids, rocks were seen for the first time since leaving Cartajena. This was the commencement of a new feature in the physical description of the country along the route examined. A species of limestone was first seen a few hundred yards above the Salado.* Afterwards the banks were formed of masses of siliceous rock, covered with a heavy clay soil. This latter was overlaid with vegetable mold. The last appearance of sand was at the camp of the previous night, where it lay under a foot or two of vegetable matter. The rocks are metamorphic, having at some recent period been subjected to violent volcanic action. They are fine grained and brittle, containing a great deal of feldspar in their composition. Until within a mile of the foot of the Falls or Saltos of the Truandó, reaches of smooth water were interposed between the several rapids. At every bend gravel points were formed, owing to the low stage of the river. The latter daily continued to fall, and, in consequence of the stretches all being short, much greater facilities were offered for conducting the survey. The river then becomes a succession of bad rapids. The channel is filled with hidden rocks, with a swift current dashing over them. The waves at times ran so high that the canoes frequently plunged their prows beneath them, and it was only by constant labor they were kept afloat. The Indians finally deemed it necessary to relieve them of parts of their loads, leaving a portion from each on a rocky point two short bends below the foot of the falls. This distance proved the most difficult part of the navigation, and great skill and exertion were required to carry the boats safely up. The excitement of making the ascent of a dangerous rapid in a small, frail canoe; the admiration felt at the dexterity dis-

*This rock, also sedementary, seemed to be a limestone of a saccharine texture, and probably by metamorphosis, crystalline. Other strata, which were mentioned above, at the table lands interposed in this neighborhood. (See report of Arthur Schott, naturalist and geologist.)

played in their management; the music of the waters rushing wildly along, and the dread of sunken rocks enhanced the charms of the magnificent scenery, bold and characteristic, which suddenly broke upon the view as the Sierra de los Saltos of the Truandó appeared before us. As the canoes rounded the last bend, a white tent was seen standing on a plateau of rocks lying at the foot of the falls. Upon landing, it was ascertained that the surgeon of the expedition and one of the third class assistants, together with one of the native macheteros, had been left behind in charge of the life boat belonging to the hydrographic party. It had been found impossible to take her up the falls, and she was hauled out of the water for safety. The rest of the party had moved forward to the head of the falls, a distance of three quarters of a mile, where they were still encamped. Their effects had been carried by hand over a narrow Indian trail which passes along the crest of a ridge of hills, bounding the bed of the river on the south.

The Indians generally ascend the river to the foot of the Saltos, and there leave their canoes. They then pass by the trail to a point above, where others, kept there for the purpose, are obtained, with which to proceed on their way. In this way they avoid the labor of ascending and descending the falls. The first impressions of the advantages of the locality for a permanent camp were not very favorable, although the appearance of the spot was wild and romantic in the extreme. One of the canoes returned to being up the articles left on the rock point below, and in a short time everything was safely landed. The constrained position which all were compelled to assume for several successive hours during the day, through fear of capsizing the narrow canoes, had proved so very fatiguing, that soon after dark all lay down to rest and enjoy some refreshing sleep.

January 14.—The camp was established on a narrow ledge of rocks at the base of a high ridge of hills, which, in the absence of any other name, received the one of Sierra de los Saltos. Its general direction is parallel to the Cordilleros de los Andes on the Pacific coast. The Truandó breaks its way through the Sierra, its bed being confined within a narrow rock-bound gap; lashed into fury by the numerous boulders which obstruct its channel, it rushes along with impetuous velocity, over a succession of rapids and falls and dangerous chutes, which defy at all attempts at navigation. About a thousand yards below the camp, the hills cease, and the river reaches the table land; near this point, a tributary enters from the left bank, down which, when filled by the mountain torrents, immense rocks have been hurled, and now lay piled up in front of its mouth; at this place, the first dangerous rapid was encountered whilst making the ascent.

The entrance to the mountain gap is about three miles above. Although throughout this length there is a constant series of rapids, still it is only for a short distance, not more than a thousand feet, that the canoes cannot be used, and recourse must be had to portage by hand. There was but little level space on the ledge of rocks, only a few yards square, upon which to camp, the surface being generally rough and much inclined.

Immediately below the spot, a deep arroyo or gully sets into the

river, which acts as a drain for several fine springs, and a little above the river forces its way through a narrow cañon, from thirty-five to forty feet in width; this is bounded by walls of rock at many places, perfectly vertical, and from ten to twelve feet in height. Upon this foundation, the Sierra de los Saltos rises over two hundred feet. The commencement of the trail which leads along its crest is extremely steep; it is an almost perpendicular rise of fifty feet; by means of exposed rocks and roots, and steps worn in the ground, and with the assistance of vines and trees upon which to lay hold by hand, one is enabled to mount it. The ridge along which it runs is extremely narrow, and is bounded on the north by the river, and on the south by a deep ravine, the slopes on either side being very precipitous. A more gradual ascent of fifty feet additional elevation, brings one to a short level about thirty feet in length by fifteen in breadth.*

This spot was selected for the sight of the fixed observatory, and subsequently became known as observatory hill. It was also made a place of deposite for the movables of the party; there being indications of previous high freshets, it was deemed unsafe to leave them on the ledge of rocks below.

The Indians had built a temporary rancho at the same place. The elevation seemed apparently greater than the ridges to the north and south of it, but the view, however, was very limited, in consequence of the dense timber which marked their profiles. The movement of camp was commenced at once; the portage of heavy instruments and provisions by hand, up a steep and difficult trail, was a laborious task.

Fortunately an addition was made to the numerical strength of the party, by forcing into service the native machetero, who had been left behind by the officer of the Navy on account of worthlessness and mutinous conduct. Early in the morning, the Indians had started for Tocome, intending to return with additional supplies after the lapse of a few days.

January 15.—This morning, a reconnoissance of the Indian trail, and also an examination of the Saltos of the Truandó were made. After passing observatory hill, the trail continues along the top of the narrow ridge, gradually ascending for the first few hundred feet, and then becoming more steep and circuitous, until the highest point is gained; the latter has an elevation above the river of two hundred and fifty feet. The gulley still continued on the south, and the river to the north; at some points, the descent to the latter is almost perpendicular. The path is very narrow, winding continuously about among the trees and vines; the soil being damp, owing to the dense shade, the walking was found to be very slippery; the feet of the pedestrian, too, were constantly being caught and tripped by some creeping vine or exposed root. At times, glimpses were had of the foaming river below, the sullen roar of the hidden falls often reaching the ear, and causing the deep solitude of the forest to echo with gloomy and mournful sounds. After the trail passes the summit, and as it approaches the point where it again touches the river, the descent becomes very precipitous; at its termination, there is a narrow plateau of ground, sufficiently level and spacious for a camp, and some ten feet above the low stage of water in the river at the time. Its advan-

tages, however, would not compensate for the labor of moving from the site already selected. Several Indian huts were standing on both banks. The length of the trail is about three-quarters of a mile. The hydrographic party had left the place but a few moments before; the camp fires were found still burning. Considering the great haste manifested to reach the Pacific, with no surveys to delay progress *en route*, it was not far in advance.

A short distance above the terminus of the trail, lay a smooth stretch of the river, its course being dammed up by immense boulders which have become deeply imbedded in the channel; this quiet sheet, bounded by high hills, presented the appearance of a mountain lake. How great the contrast between its quiet surface and the whirlpool just below, caused by the waters becoming freed from their confinement, and flowing with fearful velocity against the barriers which attempt to restrain them! This rush lasts for some three hundred feet, in which space the Truandó is confined within a narrow rock-bound channel, and falls over a continuous series of rapids; it is then received into a second basin, whose ominous silence prepares the mind for the leap the river is about to take over the Saltos Grandes or great falls.

In order to reach the latter it was necessary to climb cautiously along the banks, which fortunately, owing to the low stage of water, were high and dry; the head of these was easily reached, but to descend to the foot was no easy task; considerable care was needed, and great risk incurred of sliding down into the boiling water below, whilst clambering down the face of the rocks, worn smooth like glass by constant detrition. At last a point of rocks was gained from which the beholder could look and gaze on the beauty of the Saltos of the Truandó, upon which the thoughts of all had dwelt for so long a time, and of which so much had been said. It is a bold, magnificent fall, although not more than thirty feet in height, and well worth visiting. A large body of water rushes over it, but the eye is principally pleased by the irregularity in its appearance. Immense rocks divide the channel into three separate chutes, nor does it take only one leap, but three or four, before the surface again becomes calm and quiet.

At times there must be an immense body of water flowing through this mountain gap. Measurements of the height of drift, caught in the overhanging limbs, indicated a rise during freshets of fifteen feet above the stage of water then existing. Below the Salto Grande are four other smaller ones, all of which more or less interrupt the navigation of the river. The elevation of the foot of the saltos above the mean level of the sea, as obtained by spirit level, is 97.50 feet. There is a fall from the extreme head to the foot of them 89.73 feet in a distance of 6,413 yards. This, of course, could only be ascertained by actual measurement with spirit level, and could not possibly be estimated, as stated by another authority, even "by the most careful examinations of each of the leaps;" it is just as preposterous to attempt to obtain an accurate result in that way as to endeavor to arrive at the elevation, even approximately, of a locality by formula deduced from experiments made under the most uniform circumstances, and after-

wards apply values to the elements entering them which are dependant both upon the ever-changing velocities and irregularities of sections of such mountain streams as the Truandó and Nercua. A small tributary empties into the river immediately below the lowest salto, and is remarkable for the height of some of its falls. The boulders which lay along the banks and in the bed of the stream have been described in the geological report, from subsequent examinations of specimens collected at the time, to be of "siliceous rocks, pure masses of quartz, and chalcedony of every color, varying both in shade and degree of transparency. Some of these boulders were found sometimes loose, sometimes firmly imbedded in an iron cast matrix of trappean rock, which is the principal constituent of the mountains. Of those siliceous amygdaloid bodies several measured from four to five feet in diameter." In describing the rocks which confine the waters of the Truandó, the same report says* that the formation is a shistose crystalline one, a bold upheaval of which constitutes the Sierra de los Saltos." From this mountain file several specimens of rocks have been taken, and were all found to belong to one and the same family of trappean strata, of which mention has already been made when speaking of the little river Pie de Nercua, on the Pacific coast. These rocks all vary in external appearance, and also in texture, though they maintain at the same time certain characteristics in common. As such we consider their crystalline texture, which is often rough and granular, often smooth and glassy; also, a certain pseudo cleavage similar to that of other chistose rocks, which, like the specimens of the Sierra de los Saltos, is often scarcely traceable, but often, again, quite distinct, and finally of a dark, grayish green color, which in all probability is caused by augitic ingredients.

The outside of all these rocks, when water or weather-worn, becomes dark and lead colored, and at the same time smooth and shining, as if it were varnished with some plumbaginous preparation. Of four specimens the specific gravity was found to range between 2.43 and 2.75. These beds of trappitic rocks have evidently, since their composition, undergone a considerable degree of metamorphosis; this possibly points to a state of submersion at the time of their protrusion through the tertiary beds which border its slopes on both sides." In retracing the way back to camp an attempt was made to regain the trail by climbing from the foot of the Salto Grande up the slope of the Sierra, and it was only then that its height and steepness were properly understood; the difficulty of the undertaking was not diminished by the thickness of the undergrowth and the constant occurrence of fallen timber. By evening, camp was established on Observatory Hill.

January 16.—During the day a clearing was perfected about camp and the commencement of an open cut made through the timber, north and south, for a meridian line of sight. In the afternoon a canoe manned by two Indian boys appeared, coming up the stream, and soon after the party from the missing canoe landed. An accident had happened by which the computer was near being drowned; he made

* See geological report, by Arthur Schott.

a very narrow escape. In pursuing a wrong channel up the main river, instead of following the narrow chute around the immense barrier at the head of the Palizadas, the canoe had, in the first place, capsized whilst stemming a dangerous rapid, and subsequently, after some difficulty in righting it, a large piece of its bow was broken off, rendering it almost useless. In the last dilemma the computer came near losing his life, and was only saved by the timely assistance of the cook. The latter, leaving the former supported by an overhanging limb, dropped down the stream in search of the life-boat which went to the rescue, and relieved him from his uncomfortable position. Everything had been saved, although a large quantity of bread was damaged; considering the already small allowance, this proved a great loss. In order to obtain another canoe for him to continue his journey it was necessary to return to Tocome.

January 17 *to* 30.—During this interval the main camp remained established on "Observatory Hill." After a few days' cutting the meridian line was cleared sufficiently to be able to observe. Owing to the parallel ridges, and their densely timbered profiles, no stars excepting those of high altitudes were visible to the north; and in consequence of the low latitude no near circumpolar observations could be made. The timber proved to be very thick; the limbs, too, were so near to each other, and the undergrowth so matted together, the whole at the same time being so interlaced by hanging vines, that it was a difficult matter to fell a tree to the ground. Those standing mutually assisted to prop up the falling one. Several fine large caoutchouc trees had to succumb to the ax. The incisions into them made the sap, white like paint, run out in large quantities. Some beautiful palms also had to come down. By measurement the trunks of many were found to be upwards of five and six feet in diameter.

The astronomical telescope having been mounted, nightly observations were made of the meridian transits of stars for time and azimuth. During a single lunation transits of moon and moon culminating stars were also observed for determination of absolute longitude. In the absence of suitable materials with which to build a stand or from the inconvenience and difficulty of transporting them to the site selected, and in order not to be unnecessarily delayed, a substitute for one upon which to place the instrument had to be resorted to. This consisted of the outer packing box of the transit, which was taken and filled with rocks, and then tightly rammed with earth. As it stood upon a level rock foundation, and required the combined strength of two powerful men to budge it, the temperature remaining also so uniform as not to warp the box, it was found that the instrument, once being leveled, required no subsequent adjustment during the series of observations. A sextant and artificial horizon were used for determinations of latitude by circum-meridian altitudes of north and south stars. Observing in the tropics is no sinecure; either the sky is overcast with clouds, or during clear nights the fall of dew is so heavy as to dim in a very few seconds the instrument glasses. Stars of the fifth magnitude were seen with difficulty, and often those of the first were scarcely visible. At one moment the whole heavens would be brilliantly lit by a galaxy of bright stars, and in the next, in an inappreciably short

space of time, be completely overcast. Sometimes a transit would take place over one wire and not over another. Sometimes the first and only the last could be observed, so that the observer was compelled to be ever on the watch in hopes of catching some one or the other of the wires. On clear nights the dew had to be carefully wiped off the glasses previous to each transit.

After leaving the first camp the weather continued to be beautiful, and not a drop of rain fell. On Observatory Hill it was warm during the day in the clearing, but always cool in the shade. A sufficient warmth was experienced to keep up a good natural state of perspiration. The nights began to be a little cool, and a blanket covering was found quite comfortable. The temperature varied more than in the swamps of the Atrato, changing from 68° to 86° Fahrenheit. The latter was a delightful atmosphere, and very healthy. A meteorological record was hourly kept through each day.

On the afternoon of the 18th there were two arrivals in camp—one from Tocome, and the other from the mouth of the Nercua. The first was a canoe managed by the two Indian boys; it was loaded with provisions, and brought up the hospital steward. The second consisted of one of the Indians who had been assisting the hydrographic party, and also one of the sailors on his way back to Tocome, worn out by hardship and suffering. The guide of the expedition also accompanied them. Although up to this date he had formed one of the advance party, he was now directed to join the party of engineers. The reason assigned for this in a letter from the officer of the Navy was, that the latter had obtained an Indian as a substitute, and it was his intention to follow a different route across the mountains from that previously examined by the guide, whose survey the present expedition was sent out to verify. On the afternoon of the 20th the Indians, who had been dispatched to Tocome to assist in moving the surveying party, returned, and during the same day both officers and men arrived in camp. The survey had been brought up the Truandó to a point some little distance above the Salado. Instead of the party making only half a mile in the course of a day, as they did whilst working through the Palizadas, they were now able to accomplish over three miles in consequence of the improved condition of the river. Once more all hands slept in the same camp. On the 22d the survey reached the foot of the saltos.

In consequence of the severe labor attendant upon the portage around the falls, by way of the Indian trail over the Sierra, it was decided to attempt the transportation of the provisions and other movables along the bed of the river, making use of the canoes in the smooth stretches of water, and carrying them by hand around the different falls. This move was so contrary to the usual practice of the Indians that José, the only one in camp, doubted the success of the undertaking. He could not be convinced until its actual accomplishment and the safe arrival of the surveying party above the saltos demonstrated the feasibility of the plan. Not only were all their effects moved, but the survey itself advanced equally rapidly, and the evening of the 23d found it completed to the head of the Salto Grande. As the life-boat had to be left below the falls, it was fortunate that the Indians had a

canoe above. This, with the one already belonging to the party, enabled it to proceed without interruption.

To show the necessity of keeping duplicate notes of the survey of a river like the Truandó, an incident may be here related. After a hard day's work the surveying party rowed for some distance to their camp for the night; upon reaching it, the chief discovered that his field notes were missing from his satchel, some overhanging limbs had pulled them out, and their loss had not been previously noticed. The natives were immediately dispatched to look for them, but returned after dark without being successful in the search. The book contained portions of the notes of the survey through the Palizadas, the most trying and difficult section of the work. They had only been duplicated as far up as the village of Tocome. It was with intense regret that the party started the following morning to retrace their steps, in order to renew the survey. To the great joy of all, however, as they were floating down stream, something white was seen hanging fast to a limb, which, upon a nearer approach, proved to be the missing note book. Truly it was a providential recovery, as thereby a repetition of the most disagreeable and difficult part of the work was avoided. This proved a beneficial lesson for the future. On the morning of the 27th, José, accompanied by another Indian, returned to Observatory Hill, and reported the survey completed on the evening before to the mouth of the Nercua. The hydrographic party had left there only nine days before—some of the members had been left behind at that point. The officer of the Navy appeared gradually to be reducing his force as he advanced. Upon leaving the Nercua, it consisted of two third class assistants, two natives, one Indian, as guide, and a negro cook. With these he started to cross the mountains. Some of the natives, whom he had not taken with him, being anxious to see the Pacific, and the surveying party having need of more laboring hands, they were permitted to accompany it. The strength of the engineer corps was thus considerably augmented. As its duties were more arduous than those of the other party, the one being daily occupied in keeping up a continuous line of survey, whilst the other merely had to travel along with only the attendant labor of moving, the force of the first should have been proportionally the greater of the two from the very commencement of the work. The difference in the amount of labor accomplished by each can readily account for the slower progress made by the one than by the other.

The series of lunar observations having been completed, preparations for moving forward the remainder of the engineer party, consisting of the officer in charge, the geologist, and the meteorologist, were commenced on the 28th; they had remained behind the surveying party for several days, in order to finish their labors at the Saltos.

A depot for the large instruments and such private effects as could be temporarily dispensed with, was established on Observatory Hill, and left in charge of the computer and one of the third class assistants; the former suffered so much from swollen limbs in consequence of the irritating bites of insects, that he feared to attempt the crossing of the mountains. The Indians assisted in carrying to the head of the Saltos such small instruments and provisions as were needed in the journey

to the Pacific. As they had but one canoe, it was impossible to carry everything in one trip, so that it was arranged to make two, to enable all to reach as expeditiously as possible the mouth of the Nercua; the naturalist and one of his assistants accompanied them in the first, and they were directed to return on the following morning for a second load.

The evening of that day, the 29th, came—everything having been in readiness from early sunrise, to leave at a moment's warning, but still José and his companion had not yet appeared. It was a little disappointment to the officer in charge, for being extremely anxious to overtake the advance of his party, every hour was precious to him. The Indians had hitherto been punctual in fulfilling their agreements, and although many surmises were indulged in, still no reason could be assigned for their delay; nor was there a single canoe to be had to enable him to proceed without their assistance.

The night of that day was a long, weary one; but hope did not desert him. Twice during the interval of suspense, the trail over the Sierra de los Saltos had been walked whilst passing to and fro between Observatory Hill and the head of the falls, each time the limbs becoming more invigorated and strengthened by the exercise, and gradually preparing for the more difficult passage of the Cordilleras de los Andes.

January 30, 1858.—Whilst seated on the rocks overlooking the falls, and listening to the music of the roaring waters as they rushed fiercely past, with an occasional anxious glance at the curve of the river above in expectancy of the momentary appearance of the long-expected canoe, the attention was suddenly drawn towards a long line of Indians—men, women, and children—emerging from the trail over the Sierra. As they filed by, several familiar faces were seen, and a kindly nod of recognition given and returned. Each bore a pack, from the largest to the smallest; these rested upon the back and were supported by bands, composed of the bark of trees, which passed in front of the forehead. Most of their effects were packed away in baskets made of bark of certain trees, and very neatly manufactured. They proved to be old friends from Tocome, and were *en route* to make a visit to one of their Tambos on the Nercua. All fear as to moving ahead was dispelled at sight of them. After depositing their loads or the rocks near the small haven just above the falls, they all left again, as quietly as they had come, in order to bring up their canoes over the Saltos.

Their household effects were quite numerous: iron pots to boil in; earthenware of different kinds; cups and spoons of the cocoa nut shell; a home made material of caoutchouc cloth to sleep on; tapers of wood, one end of which had been stuck in a mixture of bee's wax and palm oil; blow guns, either used for hunting or for warlike purposes. These weapons were about six feet in length, through which a long thin arrow is blown. The latter is sharp at both ends, one of which is said to be poisoned. The other is wound carefully around with wool or cotton, and intended for game. About one hour after the first Indians had arrived and deposited their goods, the blind Indian appeared in sight. He carried on his head a large iron pot, and in his hand held

the paddle of a canoe. His wife, with a child two or three years old slung on her back by a piece of muslin, the little one sleeping most unconsciously, followed behind him, and guided by a few words his steps. She had brought him safely along the narrow trail, from which one false step would have precipitated him into the river far below. He had one of the most powerful and muscular frames among his tribe, but withal was almost perfectly helpless. About noon the Indians turned the bend immediately above the Salto Grande, all hands, male and female, assisting to bring up the canoes. They were exceedingly expert and cautious in their movements, and could frequently be seen diving with perfect ease beneath the boat they were assisting, passing from one side of it to the other whilst in the midst of a dangerous rapid. After effecting the ascent, they moved their chattels to the opposite bank and camped.

Whilst watching their progress, a chance look up stream discovered some object buffeting the waves, which, upon further examination, proved to be one of the native macheteros swimming the river and endeavoring to recover some floating article before it reached the fall. He belonged to the hydrographic party, and announced their near approach. The capsizing or swamping of a canoe above, caused a portion of its load to escape into the middle of the current.

In a short time the officer of the Navy, with most of his men, appeared in sight, and soon after landed. The two Indians upon whose movements so much patient waiting had been expended, were among the number. Although they plead sickness as an excuse for not returning sooner to keep their engagement, it was soon ascertained that, having anticipated the early arrival of the other party, they feared missing it in the event of keeping their promise, and would thus lose the pay due them for the labor already performed. As money was scarce, they consented to continue with the hydrographic party down the Truandó to the village of Boca de Sucio. This did not prove any very serious loss to the engineering party, as a young Indian and his wife, at the earnest solicitation of the geologist, who was still in waiting at the mouth of the Nercua, had been induced to come and offer their services. The latter were two of the most intelligent looking of their tribe, and in personal appearance surpassed all the others. They agreed to accompany the party to the Pacific and return with it.

The hydrographic party had made quick work of the survey on the Pacific coast, at the terminus of the canal route. Although absent from the Saltos not quite sixteen days, eleven of which were occupied in constant traveling, both in going and returning, thus leaving less than four days to accomplish, with a very small force, a most important part of the work, still its completion was reported. The party intended hastening their return to the Gulf of Darien, to assist in making the hydrographic survey on that coast, and would continue on the next day. A very romantic view was presented to the gaze before the close of evening. On the opposite bank of the Truandó, immediately above the falls, lay groups of Indians around their fires, the blue smoke curling up gracefully through the rich green leaves. In the back ground rose high rocky banks, surmounted by steep hills clothed with the dense foliage of the tropics. Immediately in front of them lay the

smooth quiet waters of the lake like stream, clear as crystal, whilst only a few feet below dashed a bold, wild rapid, its waves lashed by huge boulders into the whitest foam. Near by, in another smaller group of the aborigines, consisting of one family, could be seen, the parents fondling their little children in all gentleness. Within a few feet of them were stretched out some of the native macheteros, their swarthy limbs indicating the true Ethiopian. A short distance back, on a high bank, was the camp of the officers. American like, all kinds of effects were strewn about or hung up to dry. Hammocks were swung, or blankets stretched out on the ground, and all the appliances of cooking lay scattered around a large fire. Some were enjoying their cigars, and others their pipes, and all engaged in conversation. After dark, the bright camp fires and the Indian torches lit up the scene, throwing their bright flames upon the surface of the river, to be reflected back by its waters. For hours camp lay awake listening to the deep roaring of the Salto Grande below. Within reach of its sounds nearly all the various races of mankind had their representatives.

January 31.—An early start was determined upon. Great was the anxiety to be once more on the way, for fear that other detentions might arise to delay the overtaking of the surveying party. A shout informed Antonio that every thing was in readiness, and in a short time he appeared from the opposite bank with his canoe. Leaving the head of the rapids above the Salto Grande, and passing up a smooth reach of water for a short distance, brings one to the foot of what are called the "Long Falls." They are a succession of rapids and falls. Twenty minutes were occupied in walking along the rock banks to reach the top of them. A much longer time was needed to get the canoe and her cargo up. The heavier portions of the latter had to be carried by hand around the worst places. The Indian and his wife, a bride of only three weeks, managed the canoe entirely, and would not accept any assistance. In ascending a fall, the one would raise the bow to prevent the waves from washing over it, whilst the other pushed at the stern, both being in the water at times up to their necks. They behaved splendidly, and were always cheerful, laughing and jesting with each other all the time, and as gladsome in their honey moon as children on a pleasure excursion. It required great skill to prevent a light canoe from swamping or upsetting. The one used was about twenty feet long by two wide, and carried, besides the Indians, three persons with their private effects, and several instruments. Ten minutes after leaving the "Long Falls" a second one was reached. It was about six feet high, almost vertical, and very difficult to surmount. The river there runs between rough and irregular banks, and is very narrow, being at some points not over ten feet wide. It was then at the very lowest stage, but its velocity during high water could easily be imagined. Smooth stretches of water lay between each of the rapids. The third one was so filled with huge rocks as to require the adoption of a novel mode to ascend it. For this purpose, wooden sleepers had to be laid from the foot to the head of it, and the canoe slid over them. The wreck of one belonging to the hydrographic party was found high and dry on the rocks.

A short, gentle reach of the river then brought the party to the fourth and last series of rapids, four in number. Whilst the canoe was being taken up, the two officers of the party, the one carrying the barometers, and the other a sextant and box chronometer, passed on to a smooth water above. It required thirty minutes' constant walking to accomplish the task—sometimes jumping from rock to rock, then wading through the water, and part of the time following an Indian trail along the banks. The chronometer and barometers received several little knocks; for, besides being very slippery when on the rocks, it was troublesome to walk the trail, as it runs through very thick undergrowth; the creepers which cross the path constantly trip up pedestrians. There are well-beaten trails on both sides of the river, which the Indians use at times of freshets, when it is impossible either to ascend or descend the falls with canoes.

By noon, the ascent was safely accomplished. The length of the Saltos, along the entire series, from the head to the foot of them, is 3.65 miles, with a fall in that distance of 89.73 feet; along this section, the bed throughout is of solid rock. The elevation of the head of the Saltos is 187.23 feet above the mean level of the sea. Immediately below the upper rapids a small tributary empties in on the right bank; its waters drain the western slope of the Sierra de los Saltos. Above them, the Truandó widens into a magnificent sheet of water; dammed up by the rock barriers below, it spreads out like unto a broad lake, quiet and smooth, with scarce a ripple upon its surface. It is a beautiful river from the falls, up to the mouth of the Nercua, for a space of 3.5 miles, running over a rocky bottom, and averaging from four to six feet in depth. How great the contrast with the stirring incidents which occurred below whilst making the ascent of the falls, was the peaceful motion of the canoe above them as she glided gently along, with scarce an effort of the paddle!

The scenic effect was very pleasing. Again the river, no longer pent up between rocky cliffs, traced its course through the rich table lands which extend between the Sierra de los Saltos and the Cordilleras de los Andes; rich foliage lined the banks, though apparently the trees were no longer so high nor the undergrowth so dense. As the Sierra disappeared from view, Nature seemed to become more animated, and assumed her most cheerful smiles; all hearts seemed glad to have at last left the Saltos behind. Several small tributaries drained the country, and not unfrequently springs were seen to percolate the banks, indicating a more improved condition of the soil.

Early in the afternoon, the mouth of the Nercua was reached. The small party, consisting of the naturalist, his assistant, and the hospital steward, which had left the falls a few days before, were encamped there, awaiting the means for pushing forward. The camp lay on a gravel bend opposite the junction of the two streams; back of it was a large plantanal or plantain grove. Some of the plants were at the height of fifteen or sixteen feet, and their large, broad leaves looked beautiful. They grow up and bear fruit once in nine months; after fructifying, the stalks are cut down to the ground, and then spring up again from the roots; they were planted about four feet apart in rows like corn; although in the month of January, the latter cereal was growing finely.

After having surveyed the Truandó for a few miles above the mouth of the Nercua, the corps of surveyors had continued their work up the latter stream. They passed the hydrographical party on its way back when within two or three miles of some tambos, at which point the Indian trail leaves the valley to cross the mountains to the Pacific. Late in the evening, the Indian families from Tocome, who had also left the Saltos in the morning, arrived at camp, and stopped for the night. Their alcalde or chief was named Jesus Maria; he had previously given valuable assistance in moving the party from his village up to the falls. The officer of the Navy, in passing down, had left at the mouth of the Nercua several hundred rations of dessicated vegetables for the engineer corps, he having no longer use for them for his own party. As the original issue only extended to the end of February, and that at the reduced rates, many of the most necessary articles having already given out, this unexpected increase of supplies was much needed, especially as the strength of the force had been augmented by the addition of five men.

Whilst talking of provisions, it might be well to mention the bill of fare for the day. It consisted of a soup of assorted vegetables, boiled with a handful of rice; a ragout of squirrels and birds, the skins of which were preserved for future scientific examinations; and plantains roasted in the ashes, as a substitute for bread. Upon first arriving, Antonio's wife had supplied a lunch of smoked iguano, and some iguano eggs. The former was good, but tough, like all dried meats; and the latter were delicious, their flavor very much resembling boiled chestnuts. The eggs, about the size of a pigeon's, are laid in holes in the sand banks like those of the alligator; the shell is white and soft, and can be compressed into any shape. The color of the substance of the egg is all yellow, different from that of the alligator, which is all white.

Many iguanos were seen during the day. They are a curious looking animal, resembling large lizards. The Indians are very skillful in lancing them. By first breaking their tails, which are very long, the rapidity of their motion is very much diminished, and they are readily overtaken. An opportunity offered of contrasting their eggs with those of the domestic fowl. The latter were purchased at a somewhat exorbitant price from Jesus Maria. The Indians, wherever they go, carry with them their families and all the necessaries of a household, including dogs and chickens. The dogs know their places in the canoes, and upon starting off, jump on board. The chickens are packed away in spherical shaped baskets, and have their position assigned them amidships. At the termination of the day's journey, the latter are relieved from prison and allowed to run about. At sunset, upon going to roost, the women catch them, or they are caught at any time by the dogs, previously trained to hold on without injuring them. Some beautiful collections of plants and birds had been made at this camp. The Indian boys found some delightfully scented leaves, and some very aromatic gum; the latter is used medicinally.

February 1.—Owing to the heavens having been obscured by clouds,

no astronomical observations could be made during the night. The meteorological readings were, however, continued. By level the junction is 192 feet above the mean level of the sea. The opportune arrival of Jesus Maria and family enabled arrangements to be made to move the whole camp forward without any further delay. Two canoes in addition to Antonio's were able to carry all hands and their movables. At the junction of the two streams, the Nercua seemed to be the smaller; the Truandó supplying the greatest quantity of water. In ascending the Nercua it was found to be full of obstructions from fallen trees and rafts of drift wood; at times very narrow and deep, and then again wide and shoal. Frequently different members of the party had to get out of the canoes, either to walk along on the gravel bars or wade through the water, whilst the Indians forced them by hand up low rapids or over sunken logs. To pass such imbedded trunks as lay just on the surface of the water, strips of bark were as usual employed to slide the bottoms of the canoes upon. The utility of this method was tested about noon in overcoming an immense obstacle of the kind. It would have taken hours to cut through it. The water was too deep on either side to furnish a foothold, and the whole force required in pulling the canoe over had to be exerted at one point. The use of the bark rendered the task comparatively easy. Although the scenery along the Nercua was very beautiful, still it had lost a great deal of the wild romance of the Truandó. A great deal of timber had been felled to make clearings for platanals and cornfields: the former were constantly met. Very few large trees were left standing, most all being of small dimensions. There were enough proofs, however, among the obstructions in the river, to bear testimony to the immensity of the primeval growth.

In ascending, the stream gradually grew more and more shallow. The canoes at last could be used only for transportation of goods and chattels. The members of the party found that more rapid progress could be made by walking on the banks or wading in the water. There was one very great bend in the stream which took the canoes forty minutes to round, whilst the tongue of land was crossed on foot in a very few minutes. During the course of the afternoon Antonio's quick eye discovered a deer standing in the thicket a short distance back from the river. Before a rifle could be brought to cover it, it disappeared among the wilds of the Nercua, startled by the unusual sounds which echoed through the valley. It appeared to be of the same size, but of a darker red, than those at the north. Four and a half miles above the mouth, on the right bank of the Nercua, a thermal spring was discovered some little distance back from its bed. It was a beautiful one, the waters boiling up with considerable force and then pouring into the river. By measurement with a thermometer the temperature was ascertained to be 107° Fahrenheit. A bottle was filled with the water to be taken back to Washington for analysis. It tasted strongly of sulphuretted hydrogen. Encamped for the night near an Indian rancho. The day had been at intervals cloudy, and a few drops of rain fell.

February 2.—During the night it rained quite hard for a short time, but the morning broke bright and clear. In two hours after

resuming the journey the Indian Tambo was reached—a distance of fourteen miles above the junction of the Truandó and Nercua by the meanderings of the stream. The river still continued so low at most places, that, with the exception of a few hundred feet, the distance was walked; it was one constant wading from sand beach to sand beach, crossing and recrossing the river; sometimes the water only even with the instep, and then again almost up to the hips. This mode of transportation was not of the most pleasant nature, nor, under the circumstances, was it agreeable to remain in wet clothes for hours. A hot sun kept constantly beating down on the head, whilst the lower extremities were wet and cold. Several streams emptied into the Nercua; one of them, the Pavarador, is almost as large as that river itself, whilst the others, with the exception of the Hingadór, were very small. Three mouths of the Hingadór were passed; the first one is dry, except in high water; the second is not much larger; and the third, about half a mile below Tambo, scarce attracts the notice of the passer by. It was by an entrance through this last, that the survey was continued into the valley of the main stream, along whose bed, in following it up to its sources, the heart of the Cordilleras de los Andes was first penetrated, and its summit afterwards reached. The Nercua had proved to be very tortuous, of no great width, and very uniform in its depth; the velocity of the current was also extremely irregular, in consequence of the many obstructions throughout its channel; it runs over a bed of gravel, and is as clear as any mountain stream. The valley of the river is truly a beautiful one, much higher than that of the Truandó. The elevation of Tambo above the mean level of the sea is 264.4 feet, also 210 feet above Tocome, and 238.6 feet above Sucio. Plantain fields line its whole length, and maize, sugar, yams, yuca, and bananas also flourish. The whole appearance of the country was light and airy. To give its geological character, a quotation will again be made from the report of the geologist of the expedition, whose care it was to examine in detail the formation.* "The surface of these regions consist chiefly of quaternary strata, with a thick and most valuable cover of vegetable mold. Along the Nercua underlying strata are nowhere exposed, and it is only below the junction of this river with the Truandó that occasional tertiary layers and beds of indurated clay or argillaceous marl are met with. Though horizontally stratified, a loose structure and a predominant interference of vast alluvial beds, and, above all, the irregularly disturbed position of the layers justify the conclusion of their being but the broken up surface of an upheaved tertiary bed." The report further on says that "the nature of the gravel, forming occasional beds and banks in both these rivers, is generally the same, with the slight difference that argillaceous semi-rock, nodules, and boulders of more or less indurated clay, appear to be pretty uniform in the Nercua, whilst quartoze rocks, with a very considerable addition of chalcedony, hyalite, and other fossils of a similar nature, form a prominent feature in the Truandó gravel."

Although the examinations of the valley did not extend higher up than the Tambo, as the limited time and a scanty allowance of pro-

* See Arthur Schott's report.

visions would not authorize any deviation from the direct line of the survey, still the Indians give very favorable accounts of the regions above. It is to be deeply regretted that circumstances, over which the party had no control, prevented further reconnoissances from being made, both near the headwaters of the Nercua and Truandó; a great deal of additional light might have been thrown upon the solution of the very important problem which now attracts so much attention. In approaching the Tambo, the Cordilleras de los Andes do not become visible until within a very short distance of the village; this is owing to the dense forest intervening. On first arriving there, the only occupants of the place were two children of José; the one a girl just budding into womanhood, and her younger sister, both sisters of the wife of Antonio; they had been left entirely alone with only some two or three dogs as protectors; all the rest of the family had been absent down the Truandó, lending their aid to forward the movements of the expedition. The hospitality of the Indians was at once displayed by bringing and laying before the party upon its arrival some most delicious bananas and quantities of sugar cane, with which to refresh their white brethren after the toilsome march up the Nercua. The village, or tambo, is occupied by a few Chocó families; there were only four or five houses in the place, much better built, however, than those previously seen; the building material consisted of the palm tree, the leaves being used for thatching; the floors were some six feet above the ground. The end of canoe navigation was there reached, and the remaining portion of the route which leads across the mountains remained to be accomplished on foot.

February 3.—As Antonio and his wife had been working very hard for the last week, they desired to lay by for one day to rest. This afforded an opportunity for making at the Tambo a more complete set of observations for time and latitude. Only one incident occurred to disturb the quiet of camp. Whilst observing during the afternoon an immense drove of peccary, or wild hogs, rushed by through the platanal on the opposite bank of the stream; some of the men were directed to cross over and endeavor to get a shot at them. A short time only had elapsed when the cook reported that he had killed one, having shot it while standing in the door of Antonio's house. Upon being questioned as to whether he had not mistaken a tame hog for a wild one, he innocently answered, "No; that it had tusks." Upon subsequent examination, however, it proved to be a domestic one, the only one belonging to Antonio. It was feared that the latter would be enraged for this return of his hospitality, as the other Indians who had arrived in the morning pronounced the ominous words *muy malo* upon witnessing what had been done. On the contrary, he took the whole matter very quietly. A large portion of the meat having been purchased from him for the use of the party, the Indians took the balance and made it the occasion for a great feast the following night.

Besides the peccary and deer seen along the Nercua, there were fouud tracks of the tapir. The cries of different kinds of cats were often heard. The birds were beautiful and very numerous. Alligators still abounded, and also iguanos, a variety of delicious fish inhabited the streams.

February 4.—The night proved to be a beautiful one for observing. There was not a cloud to be seen; the sky was brilliant, each star twinkling brightly. Singular to say, no delay arose from the heavy falls of dew which usually dimmed the glasses of the instrument. The atmosphere was cool and very bracing. At daylight camp was awakened to make preparations for the pedestrian excursion across the Cordilleras de los Andes. The party consisted of the officer in charge, the geologist and naturalist, his assistant, the meteorologist, the hospital steward, and the cook, with Antonio for guide. The latter was accompanied by his wife and her two sisters. Each individual had to pack his own personal effects and such instruments as appertained to his particular line of duty; in consequence, only the most indispensible articles were carried along. The pack of the first consisted of an India-rubber blanket, a musquito bar, and a change of underclothes. In these were wrapped an artificial horizon trough and mercury, and dressing case. This bundle was strapped on the back like a knapsack; in one hand he carried a sextant, and around the neck was suspended a large sidereal chronometer. The other hand was left free to assist in climbing the mountains; a Colt's pistol hung to his waist belt. The second carried his paper for botanizing and his rifle; the third his shot-gun and materials for preparing specimens; the fourth his barometers and thermometers; the fifth his medicines and other necessary articles, and the sixth his cooking utensils and a good supply of the pork he had killed the day before. Antonio, accustomed to this mode of transportation, packed the largest load of any. It consisted of rations for the party for two weeks, which were nicely stored away in a basket. Each of the females had their loads too. Even the youngest, small in stature, and of tender years, carried a basket on her back almost as large as herself. These last were about to make their first visit to the waters of the Pacific. Although the Indians usually make the journey in one day, still for the uninitiated it is hard to accomplish even in three.

The first part of the trail, after leaving the Nercua, ran across the valley winding through the Platanal for nearly half a mile; three small branches were crossed in this distance. Soon after passing the last, the ascent of the mountain commences, gradually at first, and then more steep; the path winds up along the first ridge until near its summit, and then passes around instead of over it. The average slope is at an angle of thirty degrees, and is very uniform; here and there are some sharp pitches, which required hard scrambling to climb, and not unfrequently brought one down on his knees. At once the trail leads into a thick forest and through scattering underbrush. The latter is not so thick as that below the Saltos, whilst the trees were apparently very much like those in the valley below, although not so large and high, nor their growth so dense. No portion of the path was as bad as that at the Saltos. The greatest trouble in following it arises from the numerous small vines which constantly catch and trip the feet; its narrowness also compels one to adjust the pack to the same width as his person, unless he be willing to undergo the annoyance of knocking it ever and anon against some passing tree. Anything carried loosely in the hand is very apt to be caught in some suspended vine. Many trunks and limbs had fallen

across the path, which did not at all improve its condition. It took nearly two hours good walking to reach the top of the first ridge; every one was well out of breath, and covered with most profuse perspiration. Some few halts were made, at each one considerable rest and relief being gained by simply shifting the position of the pack. Whilst sitting on the summit of the first ridge, enjoying the distant view of the valley of the Nercua, all were agreeably surprised to see Jesus Maria and his party come up; all, young and old, save the poor blind man, were along, and each one excited by curiosity to make a visit to the great sea; although living but a good day's journey from the ocean, only a few of them had seen it. Their packs were light; nothing but provisions, consisting of plantains, smoked fish, pork, and corn; no clothes or extra garments impeded their march; the men wore merely what nature gave them, save breech cloths, made of strips of gay and gaudy calico, given them the day before in part payment for labor performed; the women were almost entirely naked, save a small piece of manta which covered the loins. As they trod lightly along, full of conscious strength and vigor, and ever erect and unflinching under the weight of their packs, their movements appeared all ease and grace; their tread is like that of a wild animal, light, yet firm and secure, each step well placed and active; their nakedness exhibited a beautiful display of muscle, as every sinew seemed taxed to its utmost. After continuing along the edge of the hill for a short time, the summit of which is 1,046.45 feet above the level of the sea by barometrical measurement, the trail descends for a short distance to the crossing of a stream of pure, cool, refreshing water, flowing towards the north, and tributary to the Nercua. Although its valley opens into that of the latter river, and might be more accessible and of easier ascent, still the Indians select the crests of the hills and ridges for their portage grounds, only crossing the valleys in passing from one to another; the earth is not so damp, therefore passable in both wet and dry weather, and the timber less thick. The soil is a heavy clay resting on a rock foundation, similar to that of the Sierra de los Saltos; no rocks or stones are visible on the surface. Leaving the first stream, a walk of thirty-five minutes over a low divide brought the party to a second one, running in a southerly direction, and emptying into the Hingadór.

Between this tributary and the point where it finally crosses the latter, the trail runs through a beautiful broad valley, very nearly level throughout. Along this stretch, an exciting walk was kept up between the two parties of whites and Indians, the latter seeking to carry off the palm, and the former not willing to yield it. A steady march was maintained throughout by each, not a word passing between them; the trail was broader than usual, and not many obstructions along it, so that the one gained but little advantage over the other. At eleven in the morning, the tree crossing of the Hingadór was reached; an immense tree which had fallen over the stream, stretching from bank to bank, suggested the name. A great deal of the fallen timber is the consequence of the high winds which sweep over these forests. Like in the valley below, however, many trees fall from their own weight; they grow to a considerable height before

branching out, and during heavy rains the leaves become perfectly saturated, making the whole mass top heavy; as their roots do not penetrate the ground to any depth, but slight support is furnished them, and often the force of gravity alone brings them down. The dull sound of falling trees constantly breaks upon the ear.

The Hingadór is a beautiful stream, about twenty feet in width at the crossing, and very shallow; descending, however, towards the head of the fall, one quarter of a mile below, it deepens and widens very much, and for some considerable extent above the ledge of rocks over which the waters prepare to take their long leap, presents all the quiet stillness of a mountain lake.

The survey was carried from the Nercua up the Hingadór to the tree crossing, a distance of very little over three miles, and then continued along the Indian trail. From the mouth to the foot of the first rapids is over two miles, with a fall in that distance of two hundred and forty feet; there is then an additional rise of eighty feet over a succession of rapids and falls, in the short space of two hundred yards, two of the cataracts alone being each about twenty feet high. From the smaller to the great falls is somewhat less than a mile; the latter has a total fall of about 130 feet, but not in one unbroken sheet of water. After a perpendicular descent of twenty feet, the force of the leap is broken upon a narrow table of rocks, and the waters then rush down over broken ledges of the same material, at an inclination of nearly sixty degrees; its width is forty feet, and on both sides huge boulders line the banks.

The great falls of the Hingadór are grand and exceedingly romantic, and equal in height and beauty too many of those in other countries, which elicit so much admiration from all lovers of magnificent scenery. The valley itself is pleasant to gaze upon; many bright streams gush into it, and impart additional charms to the already picturesque landscape of falls and rapids and rich tropical vegetation. Several thermal springs were discovered at the foot of the great falls. As the party had to wade through the water over smooth and slippery rocks, and clamber up steep precipices, it took four days to accomplish this section of the survey. Several fragments of rocks were broken off at the head of the falls for subsequent analysis. According to the report of the geologist, of which the following is an extract, "the rocky walls were found to be overcoated with a light, shaly conglomerate of a cemented texture, and containing imbedded in a calcareous matrix coarse sand and gravel. Higher up, in one of the western head branches of this stream, a more consolidated semi-rock was noticed, containing copiously-interspersed fragments of little shells. This rock seems also to be impregnated with carbonate of lime."

Leaving the tree crossing, the trail continues up the valley of the Hingadór. A walk of forty minutes brought the party to a rancho on its banks, the spot selected by Antonio for a camp at the end of the first day's journey. As it was still early in the afternoon when the place was reached, the other Indians concluded to continue on, with the intention of making the Pacific on the following day. The main stream had been crossed four times at very short intervals of time; flowing towards the southeast, after many miles of wandering, the

waters find their way through other channels into the Atlantic; two of its small tributaries had also intersected the path, but were little more than mountain brooks. The rancho, although nothing but an open shed, thatched with palm leaves, presented a very comfortable appearance, especially as rain had threatened to fall during the whole day. Fresh palm leaves were gathered and spread on the ground, over which blankets were thrown to sleep upon. The climate still continued delightful; during the day it was not uncomfortably warm, and at night no covering was needed. A remarkable feature commented upon by all was, the deathlike stillness which reigned throughout the forest. There seemed to be no animal life to dispel the quiet solitude; neither air nor light penetrated the gloom with their cheering influence.

February 5.—An early start was made from the rancho on the Hingadór. Soon after leaving the stream, the trail commenced the ascent of the divide, immediately separating the waters of the Atlantic from those of the Pacific, and in less than three-quarters of a mile the summit or highest point along the line of survey between the two oceans was reached. Its elevation above the mean level of the sea, resulting from measurements made by running a line of spirit levels across the country, is 947.44 feet From the mouth of the Hingadór, nearly 228 feet above the mouth of the Truandó, the distance to the summit in a direct line is 13,000 feet, with a rise of 687.7 feet, which gives an average slope of 2° 48′ 13″ on the Atlantic side. From the summit to the base of the mountains, along the Totumia, flowing into the Pacific, the horizontal distance is nearly 31,000 feet, making the western slope average about 1° 44′. An hour and a half of steady walking, in a direct line for one and a half mile, brought the party to the crossing of the Chuparador, the first stream flowing towards the Pacific. Along this section, the trail continued generally upon the crest of a narrow ridge; to the South lay small valleys, through which run both tributaries of the Hingadór and of the Chuparador, their head springs not being more than a thousand feet apart. The Indians usually camp upon the latter stream, as it divides more equally the journey between the Nercua and the ocean; it is a very small insignificant rivulet. Continuing on, now over small low hills, then across narrow valleys, and here and there following up some narrow ravine, the next resting place reached was on a quebrada or water hole, many of which are found through the mountains. The members of the surveying party had evidently camped there the night before, for their fires were still burning; in fact, a short distance beyond they were overtaken, progressing with their work most successfully.

About a mile and a half beyond the quebrada a beautiful stream was encountered, a small branch of it having previously been passed. It bears the Indian name Chupepe, the signification of which could not be ascertained. Before reaching it the trail ran along the top of a ridge bounded on the south by a continuous and deep valley. Such rapid progress had been made during the morning that Antonio was induced to point to the sun, just passing the meridian, and expressed a desire to push on to the Pacific. As two or three of the party were

much fatigued by the weight and friction of their packs, his invitation was declined. A bath in the Chupepe revived every one, and soon all save the geologist, who had remained behind with the surveying party, were ready for another start. At very short intervals two other tributaries of the Chupepe were crossed, each about five feet in width, and separated by low divides. Both the Chuparador and the Chupepe flow into the Paracuchichi; the latter bears their united waters on towards the great outlet, and in a few hours they are mingled with and lost among the waves of the Pacific. After passing the Chupepe and its branches there remains but one more stretch to make in order to reach the western base of the Cordilleras de los Andes. The trail then gradually ascends over a series of low parallel ridges, some four in number, and each one higher than the preceding, until the summit of a steep, slippery descent is gained, down which the path leads into the bed of the Pié de Nercua. The last part of the way was extremely troublesome and steep. A walk down the middle of the stream, during which the mouths of two tributaries were passed, known by the Indians as *Dos Bocas*, brought the party to a camping place for the night. The crossing of the mountain had been accomplished without much difficulty, although the road was a narrow, tortuous, and slippery one, besides being extremely monotonous. Being unaccustomed to carry heavy packs the party suffered more fatigue than it otherwise would have done; the unusual exercise proved very beneficial to all. During the day no very large trees had been met with on the ridges; only occasionally one was seen measuring three or four feet in diameter. Among them were varieties of the palm; the growth in the valley was large and more dense. There was a great deal of fallen timber along the whole route. No rocks were found strewn on the surface; only here and there, in the bed of some stream could any be seen, exposed to view by the constant washing of its waters. The formation of these mountain chains is similar to that of the Sierra de los Saltos already described.

February 6.—During the morning the trail for the most part continued to follow the bed of the stream, only occasionally leaving for the purpose of leading over the low hills bordering it in order to avoid some deep reach of water. These hills were steep and very slippery. Occasionally trunks of trees stretching from bank to bank had to be walked; one of them, being over a hundred feet long, and at a considerable height above the river coursing beneath, made the attempt somewhat hazardous. The Pié de Nercua is a beautiful stream, not very deep, but about thirty feet wide. After wading for thirty-five minutes its junction with the Totumia was reached. Three quarters of a mile below that point the first clearing was found; a rancho stood upon it, unoccupied however at the time. Antonio found a canoe near the place, into which he deposited the various packs, the riddance of which proved a great relief. The river was still two low and the canoe two small to transport the whole party, so that its management was left to the women. Every few hundred feet it had to be dragged over some gravel rapid. The men plodded their way along in the bed of the stream, the water at times being only a few inches deep, and then again some three or four feet. On two or three occasions all had to take to the banks on account of its depth, when Antonio, with machete

in hand, would clear a way through the undergrowth. The Totumia is at no time very wide, varying from forty to fifty feet. It is also very shallow, running over a gravel bed, and thereby enabling the party to wade the stream until within a short distance of tidal influence. There were many evidences of the great height to which it sometimes rises. The river, although it does not empty directly into the ocean, first discharging its waters in a small bay, is still subject to the ebb and flow of tides for six thousand feet above its mouth. It was not long after leaving the head of canoe navigation that the sounds of the woodcutter's ax were heard, and clearings passed, showing the advancement of cultivation from the Pacific towards the base of the mountains.

Small valleys lead out from them into a narrow belt of deep alluvial soil, bordering the line of swamp near the sea. These valleys are fresh water drains, and, not being subject to overflow, are covered with magnificent vegetation. The trees are of splendid growth, and very dense. The soil is an alluvial deposit, but of no great depth. A short distance from the mouth of the Pié de Nercua the first rocks were encountered on the Pacific side. The bed of the river is covered with boulders until it passes into the alluvial bottom land below. Rice and cornfields then came in view, and the banks were lined with plantains and bananas. The inhabitants first met were negroes, living on the banks with only a thatched roof to cover them. They speak the Spanish language, and, with native, inbred politeness, stood hat in hand when addressed. The sombrero seemed pretty much the only article of dress used by the men. Settlements soon began to be quite numerous; occasionally a half-breed Spanish señorita was seen with only a piece of manta covering the hips, and with a handkerchief hanging from the neck, intended to conceal the breasts. Two hours' wading down the stream brought the party to the rancho of one Domingo, a Spanish mulatto, with a pretty Spanish wife. A negro woman and child, both black as ebony, were fellow occupants. The establishment consisted of a roof thatched with palms and supported on poles about twenty feet high. The floor was laid with the bark of the palm, several varieties composing it, and about four feet above the ground. The sides were not closed, allowing a free ventilation of air, and the full enjoyment of the luxurious climate of the tropics on the Pacific coast. Upon being summoned by his wife, Domingo appeared, gun in hand, having been engaged in hunting. He returned with a red squirrel which he had just shot. He was possessed of an immense frame, and a proportionably loud, good-natured voice. Sugar cane and ripe bananas were offered for refreshment, and also a fruit resembling in appearance the red pepper, which, when boiled, tasted like a chestnut. The party was detained at the rancho on account of the low channel, it being ebb tide, until near noon, when, a sufficient number of canoes having been obtained, the last stage of the journey was resumed. In about a mile and a half the mouth of the river was reached, its waters, previous to spreading out into the Estero de Paracuchichí, having wound their way through a most extensive mangrove swamp, bordering the coast. The very singular appearance of thesn trees attracted the attention of all. The growth of the roots, woven together in a regular net-work, and springing out from a dark

mud soil to the height of several feet before uniting in a single trunk, is most peculiar and interesting. The trees were straight, of no great diameter, and about a hundred feet high, bearing a bright green foliage. The lower part of the stream was very tortuous, and not entirely free from obstructions. In width, it was about fifty feet, and quite deep. A low sandbar lays at the entrance to the mouth.

Passing out of the Totumia, the course of the canoes lay across a narrow bay about 750 yards in width, which separates the main shore from a long, narrow peninsula or neck of land, against which the surging waters of the Pacific ocean swell and break. The bay is known by several names. By the natives as "Bahia Ensenada," (Engulfed Bay,) and also "Estero de Paracuchichí." By the guide it is called "Kelley's Inlet," in honor of the gentleman who organized the first expedition to examine this section of country for a canal route. The peninsula is called "La Playa de Paracuchichí," (or "the Beach of Paracuchichí,") after the river of the same name which empties into the open sea a short distance to the south of its southern extremity. The mouth of the Totumia is a little north of east from the same point, and not far distant from the pass between Bahia Ensenada and Humboldt's Bay. This last bay is that part of the Pacific extending between Punta Ardito on the north, and Punta Marzo on the south. Both these capes are high, bold promontories, similar to the rock-bound headlands which mark the coasts of Mexico and Lower California. Between them lies that narrow belt of country, throughout whose length is found that great depression of the Cordilleras de los Andes, of which so much has been said and written, the low elevation of its mountain chains first having encouraged the idea of the practicability of connecting the two oceans by a canal.

Humboldt Bay receives the waters of three small rivers; the Juradór, the Totumia, and the Paracuchichí; the last is said to be the longest one. From the mouth of the former the peninsula extends in a southeasterly direction for a distance of seven miles, inclosing the Bahia Ensenada between it and the main shore. The principal mouth of the Juradór is on the open sea, but the river is connected with the Estero by a succession of lagoons, which the natives navigate with their canoes in passing backwards and forwards between its valley and the small settlement opposite the mouth of the Totumia. The village referred to is situated on the bay side of the peninsula, and was reached by the party shortly after noon. Upon arriving, the house of Domingo was placed at the disposal of the party, but all preferred camping out in the open air. A narrow trail, winding through a dense growth of shrubbery, which mantles the crest of the peninsula and still concealed from view the Pacific, leads the way to its shores. The roaring of the waves had long before greeted the ear with their welcome sounds, and but a few moments were allowed to elapse ere the superb beach was reached, gently sloping out towards the ocean and smooth as glass. For a long time all stood and gazed in silence upon the wide expanse and immensity of water before them. The Indians from the Nercua were already there. Whilst the older ones sat in silent contemplation of the magnificent scene before them, the younger were stretched along the shore in search of shells. The peninsula is a long,

narrow neck of land, not more than 700 yards in width at its widest part. It is low and flat, the highest portions being elevated above high tidal mark not more than from ten to twelve feet. A heavy undergrowth of bushes and vines grows upon it wherever the soil is not subjected to the action of salt water. On the side towards the sea a row of cocoa palms borders the edge of vegetation. A great many fine lime trees furnished delicious fruit, and made the water obtained from wells sunk in the sand more palatable by the addition of their juice. No vegetables are raised, on account of the ants, which destroy everything in their reach. The valleys of all the streams are said to be very fertile, especially that of the Juradór, and are regularly cultivated. Rice, corn, plantains, bananas, sugar, yams, yucca, and some little tobacco, form the principal productions. A few pine-apples were seen, but proved very indifferent to the taste. It was with great difficulty, however, that anything in the shape of provisions could be obtained, not on account of any deficiency of supplies, but owing to the craven-hearted character of the natives, whose sordid dispositions inclined them to practice extortion in every possible way. Owing to the small sum of money on hand, their exorbitant prices could not have been paid, even if there had been a disposition to do so. Only a little rice and some few plantains and yams could be had after a great deal of trouble.

The inhabitants were principally Zambos, a cross between the negro and Indian. There were also several representatives of the Spanish race, as well as negroes from Panama, and some even from the Island of Jamaica. All these latter more especially seemed to be a set of thieves, wreckers, and sharpers. The village contained about a dozen houses, of the build already described. Communication is kept up with Panama by means of bungos, the latter place being distant 165 miles, in a northwest direction. The most southern and western point of the Bay of Panama, Punto Mariato, is nearly on the same parallel with the village of Paracuchichi. From the Gulf of San Miguel, the Pacific terminus of the proposed ship canal route, commencing at Caledonia Bay on the Atlantic, the distance is about eighty miles. From information gained through the natives, the bungo is of the same description as those used on the Atrato, and with this rude boat, the trip to and from Panama is made in perfect safety. A shipwreck on the coast is an occurrence which very seldom takes place, and goes to demonstrate the stormless character of the Pacific, where severe gales seldom occur. Humboldt's Bay is reported to possess good anchorage ground, the bottom being of sand, and deepening gradually from the shore outwards. The waves break upon the beach in long, continuous lines of surf. The greatest difference between high and low tides was nearly ten feet at the time of measurement, on the 8th of February. During spring and neap tides it may vary two or three feet, more or less. Its waves have never been known by the natives to wash over the peninsula, and no indication of drift to prove that any inundation had ever occurred. It stands as a natural breakwater against the force of the waves. The pass from the bay into the Bahia Ensenada, is through a succession of breakers. The estero or inlet is a smooth sheet of water, averaging from twelve to fifteen feet in depth; the bottom is

of soft mud, and can be easily worked by dredging. The peninsula is not of very recent formation; and, from the authority of those living along it, has not materially changed within their recollection.

In looking back from the ocean upon the country through which the party recently traveled, the depression in the Cordilleras becomes plainly visible. It seems, in reality, to lose the mountainous character entirely, and assumes the appearance of a gradual rise or slope, with hills of little elevation in the distance. The dense growth of timber which mantles the crests of the hills makes the resemblance to a low flat region still more apparent, and when beheld from some little distance out at sea, the view must be still more strikingly so. One can easily, therefore, conceive why a preference should have been shown to this section by those interested in explorations of a route for a ship canal.

The atmosphere on the Pacific coast is extremely agreeable. Whilst there, the sun shone bright and warm during the day upon the sand beach, but the refreshing breezes from the ocean always cooled the heated air. At night one could stretch out and make his bed upon the sand with no need of covering, and let the winds play over him without fear of sickness. Bathing in the surf was indulged in daily, and proved a real luxury. Along the Pacific slope the weather is extremely dry, as very little rain falls during the course of the year. The health of the country is also excellent, there being only occasional cases of calentura or fever.

The surveying party having extended the line of levels to the Playa de Paracuchichi, the whole work on the Pacific coast was concluded on the 9th of February. This comprised a survey of the Peninsula, and of the Bahia Ensenada. Numerous sketches were also made of the profiles of the different ranges of mountains, and angles measured to their different peaks, in order to aid in constructing a general map of the country.

Whilst the members of the engineer corps were extremely anxious to discharge their duties accurately and faithfully, and to prosecute in the most thorough manner every conceivable examination which could in the remotest degree furnish additional information in reference to the great work upon which they were engaged, still circumstances over which they had no control, such as their want of provisions, and the scarcity of money wherewith to purchase and renew even necessary supplies, compelled them to turn back from the Pacific and leave unaccomplished the reconnoissance of both the Paracuchichi and Jurador rivers. To have rendered their labors complete, these examinations should have been made in connection with their other most interesting duties. The future survey of these streams, and more especially of the former, together with that of the country between its headwaters and those of the Pavarador, a tributary of the Nercua, and also between some of the tributaries of the Truandó, and the coast at some more southern point of Humboldt's Bay, may throw a flood of light upon the feasibility of the work in contemplation.

By the evening of the 12th, the whole party, together with the Indians, had returned to the Tambo on the Nercua. On leaving the Playa, the surveying party had some difficulty in procuring the neces-

sary transportation, being unwilling to submit to the exactions and insolence of the natives. By the kindly interference of some of the better disposed class, however, they were finally enabled to get away without further annoyance. No particular incidents occurred during the return trip over the mountains.

On the 13th, the descent of the Nercua was made. A sufficient number of canoes was procured to transport all the instruments and private effects of the party, whilst all hands had to wade the stream until near the junction. The canoes, after depositing their loads at the old camping ground, returned to carry them over the last few miles of deep water. A heavy thunder storm, which lasted for several minutes, was encountered at this point.

By the evening of the 15th, the foot of the Saltos of the Truandó was reached, the canoes having all been safely carried down and landed below the falls. Those who had been left behind in charge of the depot were glad to welcome their companions back after an absence of two weeks.

Antonio and his wife had only consented to accompany the party back as far as the falls, but after some little persuasion agreed to continue down to the village of Tocome. With their assistance, together with the life-boat and two other canoes, the whole party was able on the 16th to continue down the stream without leaving anything behind. As the river had been falling daily, the channel was found to be very low; it was with considerable difficulty that the boats made the descent of the rapids below the Saltos; the smooth reaches of water were soon gained, however, and they then glided quietly down the stream. The camp for the night lay a short distance above the immense barrier of drift at the head of the Palizadas. Early on the following morning the village of Tocome was reached, the descent through the Palizadas having been slow and tedious, and at times hazardous and difficult. The Indians, who accompanied the party to the Pacific, had returned the day before, and Jesus Maria was engaged in finishing a fine large canoe which he had promised to sell; with this, and the means of transportation already on hand, the whole force were enabled to move forward to Boca de Sucio, besides leaving sufficient transportation with the section detailed to complete the survey of the Truandó from the initial point of the work down to its mouth. The price demanded for the canoe was sixteen dollars, but as that sum could not be raised, a trade was finally effected; a shotgun belonging to one of the assistants, in addition to some beads and calico, accomplished the object.

For a pair of blankets Jesus promised to manage it as far as the Atrato, besides taking his wife and two children, with their canoe, to render any additional service. It was a great relief to be able to push forward without any further delay, for the stock of provisions had already become sadly reduced; some ten pounds of salt beef, a few small boxes of dessicated vegetables, and a little rice, comprised all that remained on hand to be issued to a party of twenty-two men for the next three or four days.

At Tocome the greatest regret was experienced in being compelled to part with Antonio and his wife; the former proved of the greatest

service, whilst, with the assistance of the latter, the aid rendered to the officer in charge of the engineer party was invaluable, enabling him to move with rapidity from point to point without the slightest delay or detention, and with perfect security. Along both the Truandó and Nercua they passed over the most difficult and dangerous portions of the river, where the greatest skill and dexterity in the management of the canoe were required and displayed, without the slightest accident or inconvenience; this, too, was always done without a complaint or murmur; on the contrary, they gladdened the spirits of those with them by their unwavering good humor, kindness of disposition, and constant efforts to please.

On the morning of the 18th, the party left the village and continued the descent through the Palizadas; at noon the canoes lay by for an hour at the first camp on the Truandó; owing to the continued clear weather since leaving it, the place presented an entirely different appearance, and, instead of being one mass of soft mud, the ground had become quite firm; the banks were no longer inundated, being at the time about eight feet out of water. That spot is associated with more disagreeable reminiscences than were ever experienced by those who had encamped there at any other place. José and Pedro were met there on their way back from Boca de Sucio, whither they had accompanied the hydrographic party; the latter had experienced great trouble in taking the whale boat down the Truandó. If flat-bottomed boats, suitable for river navigation, had been provided in the first place, instead of keel boats, much time and labor would have been spared the expedition. Whether or not the Indians guessed the meagerness of the supplies left on hand, was not ascertained; nevertheless they made voluntary contributions of smoked fish and corn dodgers, upon which everybody seemed disposed to make a hearty meal. Soon after leaving this place a small section of the party under the direction of the principal surveyor remained back to complete the survey of the lower Truandó, whilst the main body proceeded on their way down stream. All the provisions that could be possibly spared were left with the working party, with the assurance that additional supplies should be forwarded immediately upon reaching the settlement on the Atrato. Shortly after reaching the spot selected as a camping ground for the night, Jesus brought forward a present of several fine fresh fish, which he had just skillfully caught with hook and line, some plantains, and also the half of a peccary, or wild hog. He evidently thought that all were suffering for more substantial food than vegetable soup, without bread or even a little meat wherewith to strengthen and flavor it; perhaps the thin visages of some, or the longing eyes of others, may have indicated a slight craving for change of diet.

On the 19th the journey was continued; the only incident to disturb the even tenor of the long and tedious way was the swamping of one of the canoes and the consequent wetting of everything in it.

About noon the Palizadas were passed, and the entrance to the Lagunas reached. The day was clear and the view more extensive than at the time of the ascent; it was a great relief to leave the hitherto unbroken belt of timber which lined the river, and once more look upon the wide-spread swamp, covered with its luxuriant growth

of grammalote. Soon the influence of the winds along the valley of the Atrato was felt, and the canoes, down deep in the water, could scarcely stem against the upward current caused by them. The progress was slow and sure, with no rest during the long successive hours, for the Indians, who leisurely paddled along. The only amusement consisted in watching the lazy movements of the alligator, large numbers being constantly in sight.

On the 20th, after paddling down the main body of the river for several more hours, the party reached the junction of the Truandó with the Atrato. The latter appeared like a large sea alongside of the former; nor was the resemblance less apparent upon beholding the high waves into which the river had been lashed by the north winds, as they forcibly drove back the waters against the natural direction of their current. By hugging the banks closely the canoes managed to get along without shipping much water; at the first favorable bend the Indians shot them across the river with great rapidity, but with perfect security, although the waves were rolling very high. A little before noon the party was again safely landed at the village of Boca de Sucio, the gentlemanly agent, Señor de la Rosa giving all a most hearty welcome. Upon reaching there all trouble appeared to end, once more being back upon the direct line of examination with Cartajena and Turbo. The anxiously looked for barquetona la Concha had not yet arrived, although she was daily expected, some up river boats having previously reported her departure from Cartajena on her return trip. All were disappointed at the non-receipt of letters from home, as well as by the non-arrival of additional supplies of provisions. M. de la Rosa offered to furnish from his stores what was needed, and in the course of an hour after arriving at the village a canoe was dispatched back to meet the surveying party loaded with flour, rice, plantains, and dried fish. The members of the hydrographic party, after remaining at the village three days, had started down the river only two weeks before. Notwithstanding the great hurry and the little work attempted by them along the route between the Atrato and the Pacific, still they had gained very little time. Immediately after landing tents were pitched and camp formed. A warm sun soon enabled each person to dry his effects after five days' confinement in a narrow damp canoe. Astronomical observations for time and latitude with sextant were immediately commenced, and also a series of barometrical readings kept up. No accident occurred to any of the astronomical instruments during their long and difficult journey until the night before reaching Boca de Sucio, when one of the mean solar pocket chronometers stopped running. Upon examination the chain was found to be entirely eaten through with rust; notwithstanding it had always been carried in what was supposed to be a very dry place, still the moisture had managed to reach the works. During the few days passed at the village a second series of observations for time, made with the astronomical transit, were obtained for rating the chronometers, and also a few transits of the moon and moon culminating stars for absolute longitude. Reconnoissances of the Atrato for miles above the mouth of the Truandó, also of the Salaqui and Sucio were carried on in order to render the survey more complete. Daily additions were made to the

collections of natural history. By the swamping of the canoe in the Truandó, however, the specimens had received another soaking, and the whole time of the naturalist was occupied in drying, preparing, and arranging them for future examination.

Early on the morning of the 22d a bungo, the *Puerto Franco*, arrived from Quibdo, bound for Cartajena. As she stopped long enough to take on board a large quantity of ivory nuts arrangements were made with the patron to transport several of the assistants and men with their effects down to the gulf. Only a few remained behind besides the section on the Truandó to assist in making the survey of the Atrato. Previous to their leaving the anniversary of the birthday of Washington was borne in remembrance by the party, and although in a new republic, far distant from the one which inaugurated the present expedition, still, considering the opportunities which offered, the celebration did not fail to prove worthy of the occasion. For the first time the great name of the father of his country was toasted on the banks of that great and magnificent river, the Atrato, mighty in its strength and capabilities for navigation. On the morning of the 23d a second bungo arrived from Quibdo, and after laying by for a few hours continued on its course down the stream. In the afternoon of the same day the surveying party reached the village, having advance the survey to the junction of the Truandó with the Atrato. A continuous line of spirit levels had therefore been successfully carried between the Pacific ocean and the Atrato river. The survey of the entire route across, both in going and returning, had been effected without a single day's rest for the party. Notwithstanding the very limited means of transportation furnished, scarcely sufficient for the personnel alone, numbering the greater part of the time twenty-two officers and men, to say nothing of that needed for their personal effects and provisions, together with the heavy instruments and the large valuable collection of natural history and botany, all of which required some mode of conveyance, besides the necessity of keeping a working party constantly in the field, still all were enabled to move along without any cessation of the duty assigned them. This want of means of transportation kept ever presenting itself to the mind. Fortunately, however, the Chocó Indians always entered upon the scene when their services were mostly needed. They never failed to appear when most wanted; they would then opportunely arrive as if by Providential direction.

At times, when every possible means of advancing seemed exhausted, they would unexpectedly come to the relief of the party, and, by their laborious efforts and the skillful management of their slight canoes, enabled it to pass over the most dangerous parts of the route. One life-boat was the only real source of help upon which it actually could depend, and when compelled to leave that behind at the falls of the Truandó, on the way to the Pacific, the most unlimited reliance had to be placed upon the good will of the Indians. On the return trip this was particularly the case, with provisions almost exhausted, and with little or no money; personal effects had then to be applied to the purchase of canoes, and to gain their aid in order to expedite matters so as to reach some point at which to replenish the deficiency of sup-

plies. An overruling Providence truly favored the expedition, and watched over every step of its progress.

On the morning of the 24th of February the survey of the Atrato was commenced, at the mouth of the Truandó, by the division of the party remaining behind; the life-boat and two canoes furnished transportation as far down as the Hondo, at which place they met the long-expected Concha, and were relieved from their heavy loads. The work was continued from day to day. During each night the barquetona anchored in the middle of the stream, where she furnished comfortable sleeping quarters; the supplies brought on board of her enabled the party to luxuriate. The heavy north winds blowing exceedingly fresh every day somewhat impeded the progress of the boats, but cooled the atmosphere and drove away the mosquitoes, so that the descent of the Atrato proved a very delightful excursion. Owing to the continued clear weather the banks had also become firm and dry, enabling the party to land at the several instrumental stations whilst prosecuting its labors. On the morning of the 3d of March the station at the mouth of Caño Coquito was reached, the survey having been successfully completed to that point. By early morning of the following day the whole party were again on board the schooner Varina, anchored in the southern part of the gulf; the members who left Boca de Sucio in advance had arrived in safety a few days before. On the 5th, the officer in charge of the engineer party, with a few assistants, again left in the Concha for Turbo, or Pisisí. Several days were then occupied in making astronomical observations for time and latitude, and in terminating the series of barometrical readings which had been so successfully carried across to the Pacific ocean and back again. The place was also connected by triangulation with the terminus, at the mouth of the Coquito, of the operations along the Atrato, thus connecting the Playa de Paracuchichí, on the Pacific, with the village of Turbo, on the Gulf of Darien, by a continuous, unbroken line of instrumental survey.

The duties of the engineer party were closed on the 8th of March, but it continued to remain at Turbo, awaiting the termination of the labors of the hydrographic party, still engaged in surveying the gulf. The Varina had been absent from this duty for several days during the month of February in search of the Concha, whose long absence had created some fears for her safety. By the 21st of March the hydrographic survey of the gulf, and of the several caños of the Atrato was completed, and both parties reëmbarked on board the schooner. Everything being in readiness, on the morning of the 23d she weighed anchor and spread sails for the port of Cartajena. After several days of baffling winds the white towers of the city appeared in the distance, and in a few hours after the Varina came to anchor in the harbor. The latter is separated from the ocean by a narrow peninsula, extending for a short distance southwest from the city, and also by the Isla de la Tierra Bomba in prolongation of the same. The island is nearly seven miles in length, and, at the southern extremity, is divided from the mainland by the pass Boca Chica; the latter is very narrow at the entrance, and defended by two forts, San Fernando, on the island, and San José, a water battery, both com-

manding the channel. They are still in an excellent state of preservation, although dismantled of all their guns.

Boca Chica is the only pass now used; the main entrance, however, is through Boca Grande, lying between Tierra Bomba and the peninsula. Unfortunately for the commerce of the city, it was closed in the year 1795, to prevent the entrance of an hostile fleet into the harbor. It is a fine pass, and would not require a very large expenditure to reopen it. As the Varina approached, she passed in view before the white walls, and then again disappeared from sight for a time behind the Tierra Bomba before reaching the anchorage.

Cartajena, in appearance and build, resembles all Spanish cities. It is entirely surrounded by fortifications, and stands upon the beach, the base of the walls being washed in front by the waves of the Atlantic, whilst high hills, mantled by dense forests, rise close behind them. The site of the city is a most beautiful and romantic one, and within its walls there is a feast of rich enjoyment and pleasure. Several weeks were passed there, during the outward and homeward-bound trips.

Before closing this descriptive portion of the report, it certainly will not be considered out of place to return thanks—and most assuredly it would be unjust and ungenerous to abstain from so doing—for the extremely kind and unbounded hospitality shown the members, each and all of the expedition, both by the goodly citizens of the place, and by the highly respected and esteemed United States Consul, Don Ramon Leon Sanchez, and his most interesting family. The writer could linger for pages, in recounting their kindly acts, and in relating the continuous and successful efforts made by all to render each day one of whole-souled pleasure and enjoyment. Could it have been possible, it was almost enough to enable one to forget, in the excitement of the hour, the joys of homes and of a country left behind. The very agreeable impressions first made by the consul and his family needed only a more intimate acquaintance with them to strengthen the feelings of friendship and regard to which they had at once given rise. Most especially to them, on account of the high respect and esteem in which they were held by the Cartajeños, was the expedition indebted for the great civility and politeness shown its members during their stay in New Granada.

On the 16th of October, 1857, the schooner Varina, with the Interoceanic Ship Canal Expedition on board, cleared the harbor of New York; and after an absence of six and a half months, again anchored off the Navy-yard at Brooklyn, on the 2d of May of the following year.

IV.

GENERAL OUTFIT—INSTRUMENTS—ORGANIZATION OF ENGINEER PARTY, &c.—NATURE AND RESULT OF OPERATIONS.

General outfit—Instruments—Organization of engineer party: Its personnel and strength—Geodetic survey and line of spirit levels—Barometrical measurements—Astronomical observations and computations—Physical department, including natural history, botany, and geology.

By referring to the plan of operations, submitted to the Secretary of the Navy by the officer of Topographical Engineers on the 14th of July, 1857, there will be seen the nature of the outfit required, and in great part furnished for the expedition; and also the number and different kinds of instruments needed to make an accurate survey. In order to economize the appropriation, which from the first was too little in amount, without having been made still smaller for the purposes for which it was actually intended, by expending a very large proportion of it upon the repairs of the schooner to be employed in the transportation of the party, most of the instruments, at his suggestion, were loaned temporarily from the Bureau of Topographical Engineers and the Department of the Interior. By this arrangement, it was found necessary to purchase only a few additional ones. Some weeks previous to leaving Washington for New York, from which port the vessel was directed to sail, the following organization of the engineer party was effected:

1. Lieutenant N. Michler, corps Topographical Engineers, United States Army, in charge of engineer party.
2. John de la Camp, Principal Assistant Surveyor.
3. Arthur Schott, Naturalist and Geologist.
4. H. W. Campbell, Meteorologist and Recorder.
5. Louis Daser, Computer.
6. Jacob Schmitt, Assistant Surveyor and Draughtsman.
7. Edmund P. Herrick, Assistant Surveyor.
8. William Hawley, Rodman.
9. James Devine, Rodman.
10. Edward Gannon, Instrument Bearer.
11. Hugh Murray, Instrument Bearer.
12. Charles Wood, Rodman.
13. William Wood, Assistant to Naturalist and Observatory Attendant.

Subsequently, whilst in the field, additions were made at different times to the above force; some from the schooner, and others from the native bogas and macheteros engaged at Cartajena. The first explorer of the route, William Kennish, Esq., whose previous surveys the expedition had been sent out to verify, was also directed to join it in course of the transit across the country, having been transferred from

the hydrographic party under charge of Lieutenant T. A. M. Craven, of the United States Navy, to which section he had been acting as guide. From the commencement of the work at the first camp on the Truandó, the geodetic survey was placed more immediately under the direction of Mr. De la Camp, who retained charge of it until its termination. His force consisted of the assistant surveyors, guide, rodmen, instrument bearers, and several of the natives. The instruments used by him were the engineer's level, theodolite, and surveyor's compass. Owing to the dense growth of timber and under-brush, and the impossibility of clearing lines of sight through them, without great labor and much loss of time, the plan was adopted of making a zigzag survey from bank to bank, each course running diagonally across the bed of the stream, from one projecting point or shingle to the succeeding one above or below. By this mode the width of the stream was constantly obtained, and the water lines accurately sketched. The horizontal distances, from the instrument to each rod station, were determined by means of two fixed horizontal wires attached to the usual wire-cross in the tube of the telescope of the spirit level at the same time and with the same instrument, the difference of level between successive stations was ascertained, whilst the compass readings furnished the magnetic courses. This arrangement only involved the necessity of clearing a space for a short distance around each station, and at low stages of water advantage could be taken of the exposed sand and gravel shingles at the turning points of each bend.

The engineer's level was used from the first camp to the foot of the great falls of the Hingadór. A theodolite, with vertical limb, was then substituted for it, in order to measure angles of elevation and depression whilst following the Indian trail from the Hingadór across the Cordilleras de los Andes to the Pie de Nercua—a narrow line having been cut in advance by the Macheteros through the forest for the purposes of the survey. But slow progress would have been made over the steep and serrated ridges of the mountains with the ordinary engineer level. At the intersection of Pie de Nercua, the latter instrument was then resumed and used continuously down both that stream and the Totumia to the shores of the Pacific. On the return trip it was employed again from the first camp on the Truandó down to its junction with the Atrato, and along the latter to the village of Boca de Sucio. The survey of the Atrato was made in the same zigzag way, the horizontal distances in that case being measured by a micrometer attachment nicely adjusted in the telescope of a Bruner theodolite. The entire distances actually followed along the successive lines of survey were 90.6 miles from the Playa de la Paracuchichi to Boca de Sucio, and 81.8 miles from that village to the mouth of the Caño Coquito. The work throughout was completed between the 28th December, 1857, and the 3d of March, 1858. Unless from actual experience, no one can realize the difficulty of making a survey along and in the neighborhood of a tropical stream, or through one of the dense primeval forests of the same section of country. Mr. Schmitt was constantly occupied in taking a continuous series of sketches of the entire route, delineating all the chief topographical features of that most interesting region. During the progress of the work occasional sound-

ings of the channels of the different streams were made, and at intervals the velocities of currents measured by floats.

As there was no absolute necessity of leveling down the Atrato, the exact profile from that river to the Pacific having alone been needed, it was not attempted; the operation would have proved both a long and tedious one in consequence of the great distance and the nature of the banks; the courses and distances and breadth, with occasional soundings, were obtained, as they were needed to furnish the necessary data for making a complete map across the country. The difference between the mean levels of the two oceans had already been found by the running of an accurate line of levels along the bed of the railway between Aspinwall and Panama, to be very little, if any; the elevation, therefore, of the mouth of the Truandó above the sea, and the fall per mile of the Atrato, could be easily deduced from the results of the line of geodetic levels run between the Pacific and the Atrato, by making the mean level of the former a plane of reference. Respecting the mean levels of the two oceans, so contrary to the generally preconceived opinions regarding the matter, Colonel Totten, the chief engineer of the Panama railroad, says in his report: "Although my observations make the mean level of the Pacific from 0.14 to 0.75 feet higher than the level of the Atlantic, this is probably owing to local circumstances alone. We may, therefore, decide that there is no difference in the mean levels of the Atlantic and Pacific oceans." The field notes and computations of the geodetic line of levels from the Pacific ocean to the Atrato, together with the survey of the Atrato, are tabulated and comprised in the following tables:

Table No. 1. Columns of heights and distances between intermediate stations, and columns of the same data for each station referred to the first one at the mean level of the sea, obtained from measurements with engineer's level and theodolite.

Table No. 2. Magnetic and true courses, and also distances between successive stations.

Table No. 3. Corrections from apparent to true level.

Table No. 4. Readings and computations of angles of elevation and depression across the Cordilleras de los Andes, measured with theodolite.

The computations of the results of the above tables were made by Assistants De la Camp and Schmitt; a report by Mr. De la Camp, explanatory of said tables, accompanies them.

Accompanying the report of the officer in charge of the topographical party are sixteen maps, compiled from the above tables, in connection with the astronomical determinations for latitude and longitude, showing in detail the plans and profiles and topography of the country contiguous to the line of survey, as obtained from actual instrumental measurements:

1. Two sheets of the Atrato river, on a scale of $\frac{1}{48000}$.
2. Eight sheets of the survey from the Atrato to the Pacific ocean, in a scale of $\frac{1}{12000}$.
3. Four sheets of profile maps, in detail, of the line of survey between the Atrato and Pacific—vertical scale $\frac{1}{600}$, and horizontal scale $\frac{1}{12000}$.

4. One sheet showing a general profile of the line of survey between the Atrato and Pacific—vertical scale $\frac{1}{1250}$, and horizontal scale $\frac{1}{125000}$, and the profile of the proposed canal route, as the geodetic observations render it probable, on the same scales.

5. One sheet exhibiting a general sketch of the country between the Atrato and Pacific, and showing the general line of the proposed ship canal, as far as present information can locate it, on a scale of $\frac{1}{80000}$; also containing a general map of the Province of Chocó and the Isthmus of Panama, embracing all the ship canal routes examined in that immediate section of country, on a scale of $\frac{1}{800000}$.

In connection with the system of geodetic levels, a connected series of barometric and meteorological observations were made at a great many points, from the Gulf of Darien or Urabá to the Pacific ocean. This interesting department was placed especially in charge of Mr. H. W. Campbell. His report is appended, accompanied by the record of barometrical and thermometrical observations made at each station in crossing and recrossing the country. The character of the winds, with their force and direction, were also carefully noted, and all the varying features of tropical clouds watched and their appearance registered. Observations on the humidity of the atmosphere, measurements of the falls of rain, and determinations of the maximum and minimum of temperature, were daily tasks; additional observations with barometers were hourly noted on one day in each week; regular meteorological term day, simultaneously with corresponding ones made on the gulf coast. The record of these last were voluntarily kept by Mr. Charles Heine, principal assistant of the hydrographic party, to whom many thanks are due for this act of kindness.

The results deduced from these numerous observations are given in separate columns, among the tabulated forms. The corrections preparatory to making the computations, such as for temperature of mercury, for instrumental error, for reduction of readings to level, for horary oscillation, and for abnormal oscillation, all are described and computed for different stations, and severally collected in tables. The elevations of different points have been determined from these data, and their comparison with those obtained by the geodetic line of levels is most interesting. By reference to one of the appended tables, comprising a compilation of distances between different principal points by the actual lines measured, their heights above the mean level of the sea, their latitudes and longitudes, and also the right line distances between the astronomical stations, it will be seen how closely coincident the two different processes of measurement are proven to be. Many methods have been employed in determining the height of mountains. Some by trignometrical measurement, some by geodetic leveling, and others again by barometrical observations. Very great and unaccessible heights are generally determined by means of barometers. In the absence of all other means, approximate elevations are very imperfectly arrived at by uncertain calculations, based upon the fall and velocity of the current of a river, and its general regimen. Some authors say, that "the measurements of the fall of rivers, of their rapidity, and of the length of their course, are so deceptive that the plain at the foot of the Rocky mountains was estimated sometimes at eight thousand,

and sometimes three thousand feet above the level of the sea." The force of these last remarks has been verified in the recent survey, by contrasting the height of the foot of the Saltos above Boca de Sucio, as determined by geodetic leveling and barometrical measurements, with those furnished in the report of the hydrographic officer of the expedition, which he says were obtained by hydraulic calculations, based on the velocity of the current. Hydraulic formulæ are deduced from experiments made under the most favorable circumstances, and cannot apply to a mountain stream, like the Truandó, with an ever-varying current, and divided by immense obstructions, such as the Palizadas proved to be, into numberless channels and chutes. It would be almost equally as difficult to estimate the fall of the rapids or saltos of the Truandó, some three miles in length, by scanning with the eye each successive leap, even though the utmost care were used. Still less could any one form, without the proper instruments, an approximate idea of the elevation of that great depression of the Cordilleras by merely crossing over it, especially when compelled to follow a tortuous and slippery Indian trail, leading through a dense forest. No substitute, however simply devised, can supply the place of the level or the barometer in ascertaining the truth, and it would be as useless to think of testing such doubtful results by comparison with those of an accurate instrumental survey, as it is equally valueless in the first place to obtain them. The tedious task of running a line of levels over a serrated mountain profile, necessarily occupied more time than the mere act of walking over the same space of ground, and can readily account for the slowness of the movements of the surveying party. However slow, its labors possess the merit at least of obtaining some reliable, accurate, and much sought for information.

The hydrographic party, on their return from the Pacific, met the level party within a very few miles of the base of the mountains. Had the officer in charge of it very much desired to verify his profile of the Cordilleras, the result of measurements made with what he calls a clinometer, by comparison with that obtained with the line of levels, he could easily have retraced his steps for a few days in order to do it. The brief time of detention could have been most profitably employed in searching for a lower pass through the mountains, for which he says in his report it was his intention at the commencement of the expedition to have searched. It is to be regretted that he did not do it, and thereby throw some additional light upon the geographical knowledge of the country. As there are those who would throw discredit upon the measurements of the elevations of mountains by means of barometers, it would be well for them to compare results by that process with those obtained by geodetic leveling; as the two methods were combined during the late ship canal survey, and by no means under the most favorable circumstances, an opportunity offers for making the comparison. By experiments made during the recent Pacific railroad surveys, under officers of the corps of Topographical Engineers, several new sources of error have been discovered, and the necessity of having corresponding observations on the sea-coast to a certain extent dispensed with. Some very necessary corrections have been applied to the formulæ for computing barometrical heights, and

the results now obtained are generally very satisfactory. The labor which has been so successfully commenced towards the solution of the interoceanic ship canal problems should not be allowed to terminate. "The examinations should not, as heretofore, be restricted within narrow bounds." So writes Humboldt. In his Views of Nature, he discourses at length upon the necessity and nature of future examinations, and as his experience and advice are the fruits of so much practical knowledge and wisdom, the transfer of some few pages, relating directly both to the subject and locality, will not be out of place. On pages 434 and 435, he says, that "In the years 1828 and 1829, General Bolivar, at my request, caused the isthmus between Panama and the mouth of the Rio Chagres to be accurately leveled by Lloyd and Falmare. Since that time other measurements have been executed by intelligent and experienced French engineers, and plans have been drawn out for canals and railways with locks and tunnels. But these measurements have invariably been made in the meridian direction, between Portobello and Panama, or westward from thence towards Chagres and Las Cruces. The most important points of the eastern and south-eastern parts of the isthmus, on both shores, have in the meantime been overlooked. Until those parts shall be described geographically, according to the accurate (but easily obtained) chronometrical determinations of latitude and longitude, and hypsometrically, with reference to their superficial conformation, by barometrical measurements and elevations, I see no reason to alter the views I have always entertained on this subject. Accordingly, at the present time, (1849,) I here repeat the opinion I have often before expressed, viz: that the assertion is groundless and altogether premature that the Isthmus of Panama is unsuited to the formation of an oceanic canal, one with fewer sluices than the Caledonian canal, capable of affording an unimpeded passage, at all seasons of the year, to vessels of that class which sail between New York and Liverpool, and between Chili and California.

"According to examinations the results of which the directors of the Deposito Hidrografico of Madrid have caused to be inserted in all their maps since 1809, it appears that on the Antillean shore of the isthmus, the creek called the Enseñada de Mandinga, stretched so far to the south that its distance from the Pacific shore, eastward of Panama, appears to be only between four and five German or geographical miles, (fifteen to an equatorial degree,) or sixteen to twenty English geographical miles. On the Pacific coast, also, the deep Golfo de San Miguel, into which falls the Rio Tuyra, with its tributary the river Chuchunque, runs far into the isthmus.

"The river Chuchunque, too, in the upper part of its course, runs within sixteen geographical miles of the Antillean shore of the isthmus, westward of Cape Tiburon. For upwards of twenty years I have been repeatedly consulted on the problem of the Isthmus of Panama by companies having ample pecuniary means at their disposal; but in no instance has the simple advice I have given been followed. Every engineer, who has been scientifically educated, knows the fact, that between the tropics, even without corresponding observation, good barometrical measurements (horary variations being taken into account)

may be relied on as correct within from seventy-five to ninety-six feet. Besides, it would be easy to establish, for the space of a few months, one on each shore, two fixed barometric stations; and frequently to compare the portable instruments used in the preliminary leveling with each other and with those at the fixed stations. The point demanding the most attentive examination is that where the range of mountains between the isthmus and the main continent of South America sinks into hills. Considering the importance of this subject to the commercial interests of the whole world, the examination should not, as heretofore, be restricted within narrow bounds. A complete comprehensive survey, including the whole eastern part of the isthmus, the results of which would be alike useful in facilitating every possible scheme, whether of canals or railroads, can alone decide the much discussed problem, either affirmatively or negatively. This work will in the end be undertaken, but had my advice been adopted it would have been done at first."

The departments of geology, natural history, and botany were immediately under the direction of principal assistant Arthur Schott, Esq. These most interesting subjects are ably discussed in his "General Report on the Physiography of the Isthmus of Chocó, in the vicinity of the seventh degree of north latitude." The following is an analytical table of the various sections into which it is subdivided:

I. PACIFIC SIDE:
   1. *Coast.*
      a. The Beach.
      b. The Mangrove belt.
      c. The Alluvium.
   2. *Dip of the Cordilleras.*

II. ATLANTIC SIDE:
   1. *Strike of the Cordilleras.*
      a. The Table Lands.
      b. The Sierra de los Saltos.
   2. *Alluvium.*
      a. Palizadas.
      b. The Lagunas.
      c. The Lower Atrato.
   3. *Coast.*
      a. The Atrato Delta.
      b. The Mangroves.
   4. *Gulf of Urabá.*

Explanatory of the report is a geological profile of the Isthmus of Chocó from the Atrato to the Pacific ocean, with sketches taken from the Playa de Paracuchichí of the mountain profiles towards Puntas Ardito and San Marzo. The general report is accompanied by several appendices as follows:

Appendix A. Remarks on the geognostic structure of the country, with accompanying descriptive table of geological specimens, by Mr. Schott, showing their geological positions, and where obtained, their color, form, hardness, texture, &c.

Appendix B. Botany.—Algac.—Collection examined by Professor W. H. Harvey, of Trinity College, Dublin, with notes by Mr. Schott.

Appendix C. Botany.—Filices and Lycopodiaceæ, examined by Daniel C. Eaton, Esq., of New Haven, with notes by Mr. Schott.

Appendix D. Botany.—Notes on Phanerogamæ, by A. Schott. (The greater part of this collection was destroyed or injured by accidents referred to in the report.)

Appendix E. Natural history.—Mammals, notes by A. Schott.

Appendix F. Natural history.—Birds, examined by John Cassin, of Philadelphia.

Appendix G. Natural history.—Reptiles, notes by A. Schott.

Appendix H. Natural history.—Fishes, examined by Theodore Gill, Esq.

Appendix I. Invertebratæ, examined by W. Himpson, Esq., A. Schott, and others.

Appendix K. Table of general physical synopsis, comprising geology, botany, zoology, topography, hydrography, and ethnography, by Arthur Schott.

Many geological specimens were gathered by Mr. Schott and others from the Totumia, Pié de Nercua, the Falls of the Hingadór, the Nercua, and the Saltos of the Truandó, and brought home for examination. Samples of the bottom ground of the Atrato, at its Coquito mouth, were also obtained. Some of the water from the thermal springs along the Nercua was also bottled for future analysis. Large and valuable collections of natural history, including mammals, birds, fish, and reptiles, were also made. After being prepared and dried, as well as the humid atmosphere would permit, they were, whenever an opportunity offered, dispatched home to the Smithsonian Institute for examination and classification. Mr. Schott was assisted in the latter labors by William and Charles Wood, besides receiving the voluntary contributions of other members of the expedition. Owing to the limited amount of transportation, the want of space to prepare them, the heavy rains at the first camp on the Truandó, the swamping of canoes, and the upsetting of the life-boat, it was almost impossible to prevent the specimens from spoiling. They required constant attention and care, and every ray of sun had to be taken advantage of in order to thoroughly dry them; as it was, many fine ones were lost. His labors have been rewarded by the happy knowledge that several new species of each of the classifications of natural history have been added to the already recognized ones. The same difficulties and the same results attended his researches in the botanical kingdom. Seeds, flowers, and plants were alike collected; beautiful species of ferns, marine plants, and palms, are among the number. All of these specimens, both of the vegetable, animal, and geological kingdom, have been submitted by Mr. Schott to the examinations of different scien-

tific gentlemen, each distinguished in the particular branch of which he makes a speciality.

Astronomical observations, for the determination of the latitudes and longitudes of the principal points of interest along the line of survey, were made by the officer in charge of the engineer party. They were of two classes; those made at the most important stations, with the largest instruments, transported to them in canoes, and those made at other points by means of reflecting instruments and the transmission of chronometers.

At Observatory Hill, near the foot of the Saltos of the Truandó, the absolute longitude was obtained by observations on the transit of the moon and moon culminating stars with an astronomical transit by Würdemann, the telescope being of twenty-six inches focal length. The meridian of that camp was found to be almost precisely the same with that of the observatory at Washington. Similar observations were made at the village of Boca de Sucio. The longitudes in both cases were deduced from corresponding observations made at the Washington Observatory. The observations for latitude were made at all points with the sextant and artificial horizon, circum-meridian altitudes of stars having been taken, both north and south, and as nearly equal in zenith distance as could be found. Observations for time were made at the same places, with the same instruments, stars being selected in every instance, both east and west, of nearly equal altitudes, and as near the prime vertical as they could be found. In this way errors arising from refraction, and from the eccentricity of the instrument, were to a great extent avoided. The computations were mostly made in the field, and afterwards revised in the office. This duty was executed entirely by Assistant Louis Daser. A compilation of all the observations, computations, and results has been made by him, and are appended to this report in tabulated form. The points determined astronomically are Turbo, on the Gulf of Darien; the junction of the Hondo and Atrato; the village of Boca de Sucio; the first camp on the Truandó; the village of Tocome; Observatory Hill, on the Sierra de los Saltos; the Tambo, on the Nercua; and the camp on the shores of the Pacific. Cloudy nights prevented the determination of the junction of the Truandó and Nercua. Before closing this chapter relating to the various duties which devolved individually upon each and every assistant of the engineer party, the officer in charge of it, whose duty and pleasure it was to direct their movements, takes this opportunity of officially returning thanks to each and all of them for the zealous and untiring efforts displayed by them in the discharge of their respective duties.

The earnestness of their endeavors is shown by the great amount of useful material collected during their brief sojourn in the province of Chocó.

It was not the mere pecuniary compensation which induced them to leave comfortable homes for the hardships and dangers of a distant and much dreaded land, but all were emulated by the desire to have their names connected with the practicable demonstration of a problem, the successful solution of which the whole civilized world is at present

contemplating. The interest attendant upon the explorations of a country but little known, and one so different in its physical features from those in more northern latitudes, formed also an additional and powerful incentive to minds long accustomed to the excitement of travel. It was particularly gratifying, after success had crowned their labors, that all should have returned in good health to their homes, each to receive a hearty welcome back, and to enjoy the warm congratulations of friends after a safe return from an exciting and dangerous expedition.

Astronomical and barometrical observations for latitude, longitude, mean level above the sea, and distances between the various stations.

NAMES OF STATIONS.	DISTANCES ACCORDING TO SURVEY.		ELEVATION ABOVE MEAN TIDE.		ASTRONOMICAL OBSERVATIONS.		RIGHT LINE DISTANCES, ACCORDING TO ASTRONOMICAL OBSERVATIONS.	
	Between successive points.	From mouth of Caño Coquito.	By spirit level.	By barometrical observation.	Latitude.	Longitude.	Between successive points.	Total.
Turbo, or Pisisí					8° 4′ 56″.2	76° 41′ 50″.7		
Mouth of Caño Coquito								
Separation of Caño Coquito from Caño Barbacoas	10,225							
Separation of Caño Coco Grande from Caño Barbacoas	11,667	21,892						
Separation of Caño Tarena and Caño Barbacoas	24,947	46,837						
Separation of Caño Leon	72,466	119,303						
Mouth of Rio Tumarador Grande	21,500	140,803						
Mouth of Rio Cacarica	94,959	235,762						
Mouth of Rio Tumaradorcito	72,559	308,321						
Hondo	33,220	341,541			7° 33′ 34″.2			
Boca Larga	35,185	376,726						
Sucio	55,330	432,056	25.73		7° 26′ 16″.6	77° 5′ 40″.5		Between Turbo and Sucio. 280.325
Mouth of Rio Sucio	6,045	438,101	26.69					
Upper mouth of Rio Truandó	5,815	443,916	28.98					
Separation of Salaqui Channel	16,215	460,131	26.46					
Foot of the Lagoons (Lagunas)	76,885	537,016	27.50					
Foot of the Palisades (Palizadas)	19,900	556,916	28.52					
First Camp	42,675	599,591	44.31	58.39	7° 9′ 20″.7			
								Between Sucio

Foot of Truandó Falls	32,640	712,201	97.50	122.65			Between 2d Camp & O. H.	Between Sucio and O. H.
Observatory Hill			204.95	207.45	7° 4′ 31″.5	77° 25′ 25″.35	69,629	177,713
Head of Truandó Falls	19,240	731,441	187.23	138.1				
Mouth of Rio Nercua	18,615	750,056	192.06	192.5				
Hot Sulphur Spring	24,840	774,896	208.17					
Mouth of Rio Pavarador	31,100	805,996	233.97					
Upper mouth of Rio Hingadór	15,680	821,676	256.77					
Tambo	2,085	823,761	264.40	260.92	7° 6′ 37″.5			
Foot of Great Hingadór Falls	14,981	836,657	656.591					
Log Crossing, Tree Crossing	1,439	838,096	791.229	809.42				
Last branch of Rio Hingadór	4,332	842,428	816.055					
Principal Divide	3,365	845,793	947.443	948.5				
Rio Chuparador	5,803	851,596	835.272					
Rio Chupepe	17,946	869,542	231.694	240.24				
Piẽ de Nercua	10,858	880,400	59.415					
Barometrical Station below Dos Bocas	1,181	881,581	45.30	40.06				
Rio Tortumia	5,250	886,831	18.32					
							Between O. H. & A. S. on I. P.	Between Sucio & A. S. on I. P.
Astronomical Station on Isla de la Playa	23,925	910,756	9.10		7° 2′ 59″.6	77° 40′ 25″.35	91,015	252,779
High Tide, February 8, 1858			4.91					
Low Tide, February 8, 1858			4.90					

V.

CLIMATE.

One of the most important questions which naturally suggests itself, in first contemplating the execution of a great work like that under consideration, where an immense force of men must necessarily be employed throughout successive years, and subjected to all the varying changes of season, is that having reference to the nature of the climate of the country in which the labor is to be performed. Let, therefore, the subject of climate form a separate chapter, as it is only secondary in importance to the consideration of the engineering problems, which are discussed through subsequent pages of this report. Correct information can be gained either by inquiries made among the natives of the soil, or by the actual experience of parties who have traversed the particular section at different periods of the year, or from the records of similar works which have been constructed, where the same climatic influences are felt, and where, to a great degree, there is a strong similitude in the physical features of the respective localities. Local statistics can alone furnish the material upon which to base a correct judgment, and not the theories or fears of those who would crush a great work, either on account of selfish and interested motives, or because the narrow compass of their naturally weak minds is not able to comprehend the importance, or conceive of the possibility or realization of an enterprise of any magnitude, until they awake from their dreams to find it no longer a doubtful surmise, but an accomplished fact.

The reports of the medical officers attendant upon those public works which have been successfully advanced and completed in the tropics, and of those connected with the preliminary explorations, and reconnoissances made to locate them, show that the fatality among the men engaged upon those labors has been very grieviously exaggerated, and can be very greatly reduced by judicious hygiene regulations. In public works of any great extent, the health and comfort of the laboring classes have been of secondary consideration; but if proper measures were adopted, the additional trouble and expense in the beginning would, aside from any motives of benevolence and charity, prove in the end a great economy. The statistics of the Panama railroad show how falsely exaggerated were the rumors circulated during its construction, in reference to the mortality among the employés of the road. An examination of the reports by Trautwine, Lane, and Kennish, of their reconnoissances along the Atrato, show that there was little or no sickness among their men; this was also the experience of the late expedition. It cannot be denied that the vast alluvial deposits, through which the lower portions of the Truandó and Atrato flow, are extensive "pestiferous swamps," to use the phraseology of one of the explorers of the latter river, ever generating malignant fevers upon each turn of the spade. The work to be

accomplished there, however, is the least difficult portion, and can be done in great part by machinery. The small force of laborers required along that section can be easily supplied from the native inhabitants of the Tierra Caliente of New Granada, who are so thoroughly acclimated, like the negro race at the South during the frightful ravages of yellow fever, that the ills of the climate seldom if ever affect them. From the Saltos of the Truandó, across the Cordilleras de los Andes, to the ocean, the country is comparatively healthy, especially near the Pacific coast; it is high and more dry, being less exposed to rains, there being no precipitation for many months in the year. This section, requiring not only the heaviest, the herculean portion of the labor, but also the highest order of engineering, possesses but few of the disadvantages of climate urged against the eastern or Atlantic portion of the route. In a few months, due regard being paid to comfort and health, without at first overtaxing their efforts, laborers from any part of the world can become acclimated; the residents on the coast are strong, powerful men, seem ready for any emergency, and are able to endure any amount of fatigue. To contrast the experience of the late expedition with the information gained from the most reliable authority to be found on the Atrato, let extracts be taken from the report made by the officer in charge of the engineer party to the Secretary of the Navy, dated at Turbo, immediately after the termination of the geodetic surveys.

He says: "It affords me unbounded satisfaction to state that, during the entire absence of both the officers and men of my party in the performance of their duties connected with the survey, all have enjoyed excellent health, and return in good spirits; but few have suffered even from those trifling complaints to which all persons are more or less subject in more favored and more healthy climates. Notwithstanding the much dreaded country described to us, and the many evil forebodings of friends as to our safe return, all necessarily becoming either victims to those slow fevers generated by the pestiferous swamps through which the Atrato flows, or falling a prey to the sudden attacks of fierce animals, or suffering from the stings of venomous serpents, we have, nevertheless, reached the haven of the village of Turbo, in safety, after more than three months of laborious and trying duty, never having been called upon to endure the pain or discomfort of a single accident, and delivered from every danger, not having experienced even the fear of them. A large section of the country to which our labor confined us is celebrated for its constant humidity and inclemency, and is said to be constantly inundated by freshets occasioned by almost daily rains; very seldom twenty-four hours pass by without the latter, so it has been represented to us. We, however, have been particularly fortunate in this respect, for, if any reliance can be placed upon the information furnished the party, the contrast between the present and past season is strikingly great. Due allowance must be always made for the unavoidable love of exaggeration to which human nature is heir, more especially when endeavoring to impress the minds of strangers with the horrors of any great calamity or the difficulty of any undertaking already success-

fully accomplished by the narrator. During the two weeks at the first camp on the Truandó, it is true, the party suffered from some of the heaviest rains ever experienced by certain of its members, save, perhaps, when making, on a previous occasion, in 1854, the mule back transit across the Isthmus of Panama. Since leaving the first camp, on the 9th of January, up to the present time, the 8th of March, we have been exposed to only one brief and heavy thunder storm, and to some very few slight sprinkles of rain, incapable of any appreciable measurement. The weather has been delightful and charming in the extreme, the days were almost universally clear and not uncomfortably warm, and the nights always cool and refreshing. The stars generally show forth beautifully bright during the early part of the evening, favorable for astronomical observations, but late in the night were obscured by passing clouds."

It must be stated, upon the authority of a well-informed gentleman, a resident for several years at the village Boca de Sucio, that our good fortune was unprecedented, for, according to his statement, whether to be received as strictly correct, or with a slight allowance for the natural hyperbolical style of the Spanish, had we experienced the usual climate, and been exposed to the almost daily rains of the country, he would have expected to hear, on our return, of the deaths of most of the party, and to see those sick who managed to get back at all. From the very cordial greeting with which he received the party on its return, one may easily believe that he himself placed great faith in his own evil forebodings. According to the most reliable information, the rainy season along the gulf extends from early in April to the latter part of November. According to Trautwine, who was not only engaged for some time on the Panama railroad, but who also made explorations, during the several successive months, from the Gulf of Darien up the whole length of the Atrato, across the divide, and down the San Juan to the Pacific, the rains "are not, however, by any means excessive even during this period, but occur chiefly in the shape of short, smart showers, of from a few minutes to some hours duration, especially during the night, with occasionally heavy and prolonged falls of one or two days. It is even by no means uncommon for intervals of from three to six days to elapse during this wet season without a day of rain. Subsequent experience of some months along the valley of the Atrato and San Juan proved that by far the greater portion of the rain of that region falls during the night." As elsewhere stated, the heaviest rain during the last surveys was at the first camp on the Truandó, two inches having fallen at one time, and of that one and seven tenths inches fell during the first hour. They are not, however, of sufficient consequence to prevent work during the entire day. There are but slight variations in the temperature, the thermometer indicating nearly the same degree of heat during the entire year.

The following table exhibits the extremes of thermometrical changes at the different principal points of the route during the intervals passed at each of them:

THERMOMETER FAHRENHEIT.

	Maximum.	Minimum.
Turbo (Gulf of Darien)	94	74.6
Boca de Sucio (Atrato)	90	71
Saltos (Truandó)	84	72.75
Playa de Paracuchichí (Pacific coast)	90	69.2

By reference to the meteorological report the thermal curves at different stations can be seen for successive hours and days. The mean temperature of the tropical regions, in consequence of the trade winds, sea breezes, and copious rains, is lower than in some of the warmer portions of the temperate zone. The northerly winds prevail from the first of December to the end of March, and generally blow with considerable force; they are cool, damp, and refreshing. The fall of rain, it is true, has a considerable influence in causing not only a depression in the temperature, but also in producing the various types of bilious fever. This, of course, must be particularly the case in those vast deposits of alluvium lying at the base of the eastern slope of the Cordilleras, more especially near the mouths of the Atrato and Truandó, where the currents become sluggish and the drainage less perfect. There is, however, but a very inconsiderable portion of the labor to be performed at these points, the greater part of which can be done by machinery. The healthier portion of the year—namely, the dry season can also be selected as the more suitable and advantageous time in which to operate.

"There is no doubt that in alluvial plains, which are generally level and well watered, the slow current of the streams and the luxuriant vegetation give rise, by the decay of vegetable matter, to the development of miasmata and gaseous matters, which produce fevers of an intermittant and typhoid character. Mankind are not necessarily victims to those diseases, unless by absence of precaution, or a lowered state of health, the constitution becomes impaired, so that it is unable to resist the miasma. Cleanliness of skin, temperance in eating and drinking, and clothing to defend against alternations of temperature are sure preventives against the influences of a moist climate and a damp soil—influences which are equally hurtful whether in New England or on the plains of Mexico."

After the labor of digging a canal has once been commenced, and the necessary drainage effected, so as to carry off the surplus waters from heavy rains, and the forests cleared to some extent, so that the rays of the sun may reach and dry the ground, many of the causes of disease will disappear. The very interesting report of the Isthmus of Tehuantepec, by J. J. Williams, Esq., principal assistant engineer of

the recent survey made there under the direction of Major J. G. Barnard, of the topographical engineer corps, and from which the above extract was made, furnishes additional information and data in reference to the climate of those tropical regions, which is deserving of attentive perusal.

Passing from the alluvial valleys to the higher mountainous regions, the country is found to be remarkably healthy and dry, and the mean temperature much lower than along the rivers. Descending then the western slope to the shores of the ocean, the atmosphere becomes quite warm, and is also pure and dry. The sea-breezes, however, cool the air, heated by the warm rays of a tropical sun, and one feels as if he were in an entirely different region from that on the opposite slope of the Cordilleras. This is a peculiarity of the whole Pacific coast.

But why dwell longer on these subject-matters of climate and health? If the climate should even be, as would appear from an official report made to the Secretary of the Navy, the "worst on this continent," and productive of such "fatal" effects by causing an unheard-of mortality amongst any force sent there to labor, thereby offering a "formidable obstacle to any extensive operations;" why, if so much weight and consideration be given to this subject of climate, and upon that ground alone kill the enterprise, should a government expedition have been organized at all for making the necessary instrumental surveys to ascertain the feasibility of building the ship canal?

If the practicability of the scheme is alone dependent upon the nature of the climate, the question could easily have been decided long ago; for certainly sufficient data on the subject had been previously collected to enable a correct opinion to be formed. Why should the argument of health possess so great preponderance in determining the success of this particular work? In no great public undertaking tending towards the advancement of civilization has the loss of life ever been counted as one of the items in the cost of its construction. War, pestilence, and famine form parts of the mechanism of nature, by which the world is freed from its surplus population, and it would seem that Providence has so ordained it. Then why should a magnificent enterprise partially fail for considerations of so little weight, especially one that would benefit mankind throughout every nation in the world, not only socially and commercially, but by facilitating the intercourse between nations, by aiding to spread into the furthermost parts of the earth enlightened civilization and true Christianity?

VI.

DISCUSSIONS OF THE ENGINEERING QUESTIONS RELATING TO THE PRACTICABILITY OF UNITING THE ATLANTIC AND PACIFIC OCEANS BY A SHIP CANAL, INCLUDING ESTIMATES OF WORK AND COST OF CONSTRUCTION.

RIO ATRATO.

The distance from the village of Boca de Sucio, near the mouth of the Truandó, to the mouth of the Caño Coquito, as obtained by measurement along the channel, is (75.25) seventy-five and a quarter mile, and the difference of level between the water line of the river at the first locality and the mean level of the sea at the latter point, at a time when the stage of water was more than usually low, is 25.73 feet, as determined by spirit level; while at an extremely high rise of water, or freshet, when the banks are overflowed, it has reached 36.5 feet. These two numbers show the extremes in either case. Although uniform motion cannot be realized in practice, still, from hydraulic formuæ, based upon the conditions of uniform sections and uniform inclination, approximate velocities of a river, like the Atrato, may be deduced for each of the above stages of water. Such determinations must only be used, however, until replaced by others derived from actual observation; none of the latter could be obtained by the engineer party whilst descending the river, in consequence of high north winds forcing back the current. The bed is as regular as can be expected in large rivers, although the areas of its sections constantly vary, and consequently must influence the results. The formula generally in use, and adopted by English engineers, is—

$$v = f\sqrt{\frac{s}{p} \cdot \frac{a}{l}},$$

in which $v =$ the mean velocity, $\frac{s}{p} =$ the hydraulic depth, s being the area of section, and p the wetted perimeter; $l =$ the length; $a =$ the elevation or fall in l; $f =$ the constant of friction, derived from the resistance offered by friction arising from the bed being in contact with the particles of water. The greater the wetted perimeter for any unit of length, the greater the resistance—the latter also increasing in proportion to the square of the velocity and dependent upon the nature of the soil; this constant has been deduced from numerous experiments on river and canal beds of every description, and ascertained to vary between 90.9 and 75.75—the former for a straight course, uniform fall, and uniform area; the mean of the two, 83.3, may be applied to the Atrato. "The velocity of the regime is strictly related to the species, or rather size, of the substances which form the character of its channel. Dubnat has made some experiments upon the subject of great interest," so says D'Aubuisson. The ratio between the mean velocity and the surface velocity, has been investigated by many hydraulic observers. Eytelwein, after long experience, furnishes

the formula, mean velocity = (1-0.004 depth,) surface velocity, which being dependent upon the depth of the stream, appears more reliable. Defountaine has concluded from his observations on the Rhine, that allowance being made for the wind, it is found exactly at the surface. Others give the mean velocity greater than the surface velocity, whilst Dubnat has observed "that the mean velocity is a mean proportional between that of the surface and that of the bottom;" and Prony gives it a little over 0.8 of the observed surface velocity. Placing the average depth of the Atrato at 50 feet, the mean velocity becomes 0.98 of surface velocity. By the survey, the average breadth of the river on the surface is 1,100 feet, with a depth of 50 feet; the slope of the banks being 1 perpendicular to 1 base. The area of a section would then be 52,500 square feet, approximately, and the wetted perimeter about 1,150 feet. The following values for the different expressions may therefore be substituted in the formula, giving to *a* successively its values corresponding to each of the extreme stages of the Atrato: S = 52,500 square feet, P = 1,150′, C = 75.25 miles, F = 83.3, and a = 25.′73 or 36.′5. With the first value of *a*, the formula gives the mean velocity 4.5 feet per second, or 3.06 miles per hour, and the second 5.4 feet per second, or 3.68 miles per hour. D'Aubuisson says that "from the smallest brook of the plain to the impetuous mountain torrent, even to the great river Amazon, we have such a continued series of velocities and discharges, that it is impossible to take them as a basis for the classification of rivers;" and then goes on to add, that "we shall call the velocity of any river small when it falls short of 1.5 feet; that of the Seine is about 2 feet in the vicinity of Paris; an ordinary velocity will be 2 to 3¼ feet; above that it is great, and very great if it exceeds 6½ feet, which is nearly that of the Rhone and the Rhine; it is even double in time of great freshets." Colonel Long, in speaking of the Mississippi, says that "the descent of the river from New Orleans to the Gulf of Mexico, in ordinary low water, is about two feet, while in very high water, the river overflowing its natural banks, the descent amounts to some 14 or 15 feet; hence the current in the former has a velocity of about one and a half mile per hour, and in the latter of five to six miles per hour, varying according to the stages of the water." The velocity of the Atrato, then, can offer no obstacle to its navigation.

In Captain Kennish's report, page 33, on the interoceanic ship canal, he computes the "height of the Atrato at its junction with the Truandó." This point being but a short distance above the village of Boca de Sucio, the latter place was preferred in the level survey as a better position for a bench mark, on account of the greater elevation of the bank there; the latter serving as a convenient vertical surface on which to mark and measure the extreme varying stages of the river, and the station is the most accessible and convenient one for future reference. In speaking of the Atrato, he says, that "the mean central current of the river is about 2.7 miles per hour, with a mean depth of fifty-three feet, and the formula upon which the calculation is based is, that the square root of the mean hydraulic depth, multiplied by the fall—both in feet—will give the mean velocity of the current in feet per second under a deduction according to the volume

of the stream, the directness of its course, and the nature of its banks. In Beardmore's tables of the discharge by water courses of large area, the deduction is from one-ninth to one-eighth. It will thus be seen that the formula used by Kennish is the same as used in the foregoing computations, with the slight difference that the constant of friction in the first formula is applied by him, in the form of a deduction from 100, changeable according to the nature of the river bed.

He goes on to say that "the Neva at St. Petersburgh has a mean depth at a low state of sixty feet, and is, in many respects, similar to the Atrato. The facts relative to it have been well established, and the greatest deduction which the observations give is two-fifths." He concludes by saying that, "in applying the formula to the Atrato, and taking the observed current as the mean velocity of the water, the rise would only be 9.5 feet; the correction in this case becomes an addition, as the current is one of the data. After much calculation, and a careful consideration of many observations of the Atrato, I have fixed the height at 15.2 feet." Let the accuracy of this result be examined, and see whether it will stand a strict verification. The area of a section of the river is ascertained to be about 52,500 square feet, and the wetted perimeter 1,150′; these dimensions were approximately determined by survey, and are used in the previous computation. With these data, assuming the mean current to be 2.7 miles, or 3.9 feet per second, and the length of the river 67.75 miles, as given in Kennish's report, and by applying the deduction of 0.12, his height of 15′.2 is got. According, however, to the time table which he kept whilst drifting down the channel of the river, he occupied twenty-four hours and forty-five minutes in making the descent of a distance which he calls 67.75 miles. This would give a surface velocity of 4′.01 per second, which, after applying the proportion 0.9 between surface and mean velocity, shows that the datum 3.9 per second, used by him in computing the height, is slightly too large. The length of the river, however, instead of being 67.75 miles, was determined by the engineer party to be 75.25 miles. This distance, divided by twenty-four hours and forty-five minutes, (the time of Kennish's descent,) gives a surface velocity of 4′.45 per second, which, by applying the ratio 0.9 between surface and mean velocity, gives a mean velocity of 4.005 per second. With this velocity, and using the constant of friction 83.3, the formula—

$$v = f \sqrt{\frac{s}{p} - \frac{a}{l}},$$

gives an altitude of 20.08 feet. Again, by adopting a greater ratio than that used between the surface and mean velocities; namely, the mean velocity = 0.98 surface velocity, as has been already shown to be probably the most correct, thus giving a mean velocity of 4′.37 per second for the corresponding surface one of 4′.45 per second, the result obtained from the formula will give 23.9 for the altitude. This last altitude—23.9—does not differ much from the one 25.75, obtained by the geodetic survey. Once in the Atrato, it is navigable for vessels of the largest tonnage during the entire year; the strength of the current varies slightly from natural causes, but at all times can be stemmed by steam tugs having in tow vessels of the heaviest draught.

At certain seasons, the winds are sufficiently favorable to enable vessels to sail up for a hundred miles above the delta. A more magnificent river for navigation does not exist; being both broad and deep, with long straight reaches, its dimensions are sufficently great for every practical purpose. Owing to the very low tides in the Gulf of Darien, their influence is not felt in the river. At present, the only obstacles to its navigation are the bars which impede the entrances to the mouths of the several caños.

OPEN CUT CONNECTING DEEP WATER IN THE GULF OF DARIEN WITH DEEP WATER IN THE ATRATO.

In common with all rivers discharging their waters into open seas, the entrances of the mouth of the Atrato are very materially closed against all navigable vessels, save the ordinary river boats or bungos, by tidal bars. These bars are formed by depositions of alluvious matter, which invariably occur when antagonistic action takes place between the currents of rivers and the tidal waves of oceans. The fresh waters bearing along the washings of the plains and mountains above, meet and are intercepted by the salt waters, which keep in perpetual turmoil the sands from the bottom of the sea, and, together mingled in one mass, seek a common bed. They stretch entirely around the Delta formation, through which the river pours its waters into the gulf. As one force or the other predominates, whether strengthened on the one hand by a river flood, or on the other by steady sea winds, these bars are pushed further from or brought in closer proximity to the mouths. They undergo many displacements, some of them very sudden, according to the predominating force and the rapidity of its actions. Held for a time in a semi-fluid state, and composed of very minute particles, this sediment at length becomes hardened by the constant beating of the tidal waves, and in the end forms serious impediments to the egress and ingress of suitable trading boats from and into their river.

Floating trees and logs and vegetable drift become sometimes imbedded on these bars, but more frequently they are washed out of the channel on to shoals near the banks. They there form a nucleus to which other swimming matter may catch and cling, and around which new alluvious deposites form, vegetation then rapidly follows, and each succeeding growth gives stability to what before was floating drift; islands and necks of lands are thus made, which, by their gradual encroachments, steal away the domains of the sea. The most efficacious plans for removing these impediments, and to open a channel, from deep water in the gulf to deep water in the Atrato, for free ship navigation, must now be discussed.

The largest of all the caños called Taréna, runs nearly due north. At its junction with the Barbacoas, its width is 1,550 feet, which is said to diminish very considerable along its entire length; in depth, it averages from thirty to forty feet. Owing, however, to its course, and the exposed position of its mouth during the ordinary winter winds, the bars at its entrance are subjected to great and sudden changes.

Trautwine says in the report of his Atrato survey that "from December to March, (both inclusive,) during which interval the north and northeast winds from seaward prevail, and at such times as the river is not much swelled by heavy rains in the interior, the bars with a northern exposure accumulate rapidly by the heaping of sand from the gulf, until they become nearly dry." For these reasons the mouths of the Candelaria, Pava, and the Barbacoas, as well as that of the Taréna, would not prove advantageous localities for executing any extensive works having in view the opening of passes through them for the purposes of navigation. The next caño in order towards the south is the Coquito, apparently the most insignificant one of all as regards its dimensions, possessing, however, the advantage of having its mouth protected from the prevailing winds by the *Isla del Muerto*, (Island of the Dead,) a long, low, flat island lying to the north of it; it is therefore less exposed and less subject to changes, and has become the channel in general use through which the river boats pass from the gulf into the main river. The report referred to above adds "that those mouths which are comparatively sheltered from the effects of the northers and from the swell of the sea are, of course, less liable to the heaping up of bars of sand from the gulf; and consequently their obstructions, although consisting of softer material, (mud and fine sand brought down *by the river*, instead of the coarse sand *of the gulf bottom*,) maintain a more permanent regimen, and would, consequently, be more readily susceptible of artificial improvement." Although not the most preferable selection for operations of the kind, still the general course of the Coquito caño has been adopted by Mr. Kennish as the proposed line of an open cut to connect the gulf with Caño Barbacoas. The latter caño between its junction with the Taréna and that of the Coquito, a distance of nearly seven miles, has an average width of 600 feet, and a depth varying from 36 to 24 feet; at only a few points, therefore, would the channel have to be dredged to secure a mean depth of 30 feet throughout its length, to accomplish which very little work would be required. The general course of the Caño Coquito is northeast; the distance on a direct line from its junction with the Barbacoas to its mouth is 11,000 feet, and thence across the tidal bar to soundings of 30 feet is half a mile. Through this distance of 4,546 yards a channel has to be cut sufficiently deep to accommodate the largest sized ships. The soundings in the caño itself give from 6 to 12 feet, and those on the bar from 2 to 4 at low water. The dimensions of the cut determined upon as sufficiently great for commercial purposes are 100 feet in width at water surface, and 30 feet deep in channel. Owing to the nature of the soil of the bed and banks, which consists of soft mud and fine sand, the sides of the cut will have to be protected by some artificial means; the slopes must be faced by some material sufficiently durable to resist not only the action of the current, but also the effects of heavy rains. As the banks, however, are so low, almost submerged for the greater part of the year, and the velocity so gentle and so much reduced by the flow of the gulf tides, its action on the soil will be very much diminished. Nature has already furnished one of the simplest plans for affording this protection in the dense aquatic vegetation which already exists throughout the delta. Addi-

tional shrubbery might be planted, or short piles interlaced by such vines as are now the natural growth of the locality, be driven down for a few feet. From the nature of the soil it can never cave in. The velocity being destroyed to a great extent by such simple practical methods, the particles of alluvion floating in the water will be gradually deposited and aid in giving stability to the banks. The mud excavations from the cut can be thrown on either bank, and thus permanent levees be built. In a very few years the cut would become permanent, and have a fixed regimen like the Atrato; although the banks of the latter have a still more abrupt slope than that recommended for the cut, 1 base to 1 perpendicular; more expensive plans could be adopted, such as driving to the depth of a few feet rows of sheeting piles a few feet back from the edges of the cut, and replacing the soft mud on the outside of them by puddlings of clay and fine sand, or small broken stones. Nature in the lavishness of her vegetation offers the best, simplest, and most economical method.

All the work at the mouth of the Atrato will be subaqueous, and must be done by dredging machines. As the soft nature of the ground will forbid the erection of dwellings for the laborers, it will be necessary to make such arrangements and furnish such comfortable accommodations on the boats as will enable them to live on board. The foregoing ideas possess no novelty, but are the results of practical experience among enlightened and scientific engineers In reference to the deepening of the channel over the tidal bar, Trautwine says in his report, that "the bottom consists of mud and very fine sand, so soft that a pointed pole can readily be pushed into it for six or eight feet. I suspect that by confining the channel from the mouth outwards, (to such a distance as would meet the required depth of water,) so as to prevent its spreading over a wide surface as it issues from the caño, the force of the ordinary gentle current, aided by the more rapid ones of flood stages of the river, would of itself deepen a channel sufficient to allow, at all times, the passage of such boats as could regularly ascend the Atrato to Quibdó, a distance of about 220 miles. At all events, this could be readily effected by the aid of a dredging machine. As to the mode of confining the channel, I would follow the example set by nature herself, in constructing similar works at the same spot—encouraging the deposit of sediment along the banks by placing two rows of poles, water-soaked logs, branches, &c., to form the nucleus for receiving and retaining it. The process should be expedited by throwing upon these some of the mud of the intermediate space. This deposit would immediately become covered with vegitation, by which its durability would be secured. It is by a process precisely analogous to this, that the river has already thrown out and still is rapidly extending the banks of the various caños into the gulf. From the fact that the depth increases so immediately from six to forty feet, and from that to seventy, I conceive that a long time would elapse before the accumulation of sediment at the outer extremity of this artificial channel would be productive of inconvenience."

In Mahan's Civil Engineering, the author says: "To obtain a sufficient depth of water over bars, the deposit must either be scooped up by machinery and be conveyed away, or be removed by giving an

increased velocity to the current. When the latter plan is preferred, an artificial channel is formed by contracting the natural way and confining it between two low dikes, which should rise only a little above the ordinary level of low water, so that a sufficient outlet may be left for the water during the season of freshets by allowing it to flow over the dams. If the river separates into several channels at the bar, dams should be built across all except the main channel, so that by throwing the whole of the water into it, the effects of the current may be greater upon the bed. The longitudinal dikes, between which the main channel is confined, should be placed as nearly as practicable in the direction which the channel has naturally assumed. If it be deemed advisable to change the position of the channel, it should be shifted to that side of the bed which will most readily yield to the action of the current."

The delta of the Atrato, in many respects, resembles that of the Mississippi, and the plans recommended by the board of engineer officers for deepening the channels over the bars of the latter, are alike applicable to the former, and can be employed under more favorable circumstances. The velocity of the Atrato is ordinarily greater, and, there being no very great antagonistic force opposing, in consequence of the slight difference between high and low tides, the motion is more uniform and constant; there is less sedimentary deposit, and the character of the bed is different, being soft mud and fine sand, easily worked by dredging with buckets, instead of tenacious clay, difficult to be removed by that process; there is an absence of that peculiar formation called *mud lumps* found in the Mississippi; there is no gulf current, like in the Gulf of Mexico, and in comparison with those of the Mississippi, the mouths are not subjected to such great exposure from violent winds; the spring freshets of the Mississippi are also much more formidable than any that take place in the Atrato; and, lastly, instead of a wide channel of three hundred feet to be deepened to the depth of twenty, the proposed ship canal only requires a width of one hundred feet and a depth of thirty, thereby being able to strengthen very considerably the force of the current by throwing the entire mass through a more contracted cut. From the report of the Navy officer in charge of the hydrographic party of the expedition, the following extract is taken in reference to the subject of the improvement of the Atrato bars, now under consideration: "The best ability has yet failed to discover a means of deepening the bars of the Mississippi. It appears to me as hardly worth while to discuss a problem which has so long puzzled our most ingenious and scientific men." As these remarks may lead those uninformed on the subject, and to whom the official reports on file in the War Department may not have been accessible, into erroneous opinions as to the results of operations carried on by officers of engineers under appropriations from Congress for deepening those (the Mississippi's) channels, let several extracts be here presented from a most interesting letter by Captain A. A. Humphreys, corps of topographical engineers, addressed to the editors of the National Intelligencer, on the 29th of February, 1860, in relation to the bars of the Mississippi. They furnish a satisfactory and conclusive reply to the statement made, and present some very useful

information upon a subject which appears to the officer of the Navy "hardly worth his while to discuss." It may be premised that Captain Humphreys was a member of the board of engineers organized in 1850, "to decide upon the extent and character of the survey to be made" in reference to the inundations of the Mississippi. Unfortunately, the zeal of Captain Humphreys induced him to remain so long and so late in the field during the summer of 1851, that he was compelled to be relieved at that time from the duty; and to recuperate his health, he was sent to Europe, and directed to examine into the improvements of rivers abroad. In 1856, he again resumed his labors relating to the Mississippi river, and is now engaged upon an elaborate report on the subject. He states that, "The bars at the mouth of the Mississippi are always forming, and a perpetual annual expenditure must be incurred to increase permanently the depth of water upon them. In this all engineers who have written upon the subject agree. The appropriations for that object have, however, been given irregularly, and at intervals of several years, so that the deepening of the channels effected by one appropriation, has been filled in long before the passage of the next. In fact, by the omission of the work of a single season, the bars may return to their original condition. To be of practical benefit to navigation, the depth of the channels must be perpetually increased, a condition that could never be obtained under the system of appropriations heretofore followed." He then proceeds to make the following statement, derived from official records: "When the first appropriation for improving the navigation at the mouths of the Mississippi river was passed, in 1837, an extended and elaborate survey of the passes, mouths, and approaches was made, (a survey of great value,) and the plan of deepening by dredging with buckets was recommended, and its cost estimated for by the officers in charge of the work. This plan was approved by the board of engineers, sanctioned by the War Department, and carried into effect, as far as the appropriation admitted. It was taken for granted that a work thus begun would be continued by further appropriations, but no other was made until that of $75,000 in 1852, with the requirement that the work should be done by contract. A board of officers was then appointed by direction of the War Department to report a plan of operations. The board recommended:

"*First.* That the process of stirring up the bottom by suitable machinery should be tried.

"*Second.* If this failed, that dredging by buckets should be tried.

"*Third.* If both these modes failed, that parallel jetties should be constructed, five miles in length, at the mouth of the Southwest Pass, to be extended into the gulf annually, as experience should show to be necessary.

"*Fourth.* Should it be then needed, that the lateral outlets should be closed.

"Finally, should all these fail, a ship canal might be resorted to.

"The recommendation of the board to dredge by stirring up the bottom, was approved by the War Department; and a contract was accordingly entered into for deepening the Southwest Pass to eighteen feet. The contract *was successfully executed,* and a depth of eighteen

feet obtained in 1853. No further appropriation was made until 1856, and, as anticipated, no trace of the deepening was left in 1855.

"In 1856, $330,000 was appropriated for opening, and keeping open, by contract, ship channels through the Southwest Pass and Pass à l'Outre." In reference to this last appropriation, Captain Humphreys states further in his letter, that "the contractors began by building a jetty of a single row of pile planks, strengthened at intervals by piles, about one mile long, on the east side of the Southwest Pass. Portions of it were carried away by storms, and the contractors abandoned the plan, convinced that they could not, with their means, effect the desired result in that way. With the sanction of the department they then resorted to stirring up the bottom by harrows and scrapers, dredging with buckets in some places, and blasting the mud lumps. It was by such methods that *they succeeded,* by June and September, 1858, *in opening the two channels to a depth of eighteen feet*—their contract having been modified in respect to the depth; and, as long as the process of stirring up the bottom was continued by them, the channels preserved the requisite depth."

It may be remarked here that these contractors deepened the two channels to eighteen feet for the sum of $250,000, while the New Orleans Tow-Boat Association proposed to deepen them to eighteen feet for the sum of $325,000; and that the contractors in the latter part of 1858 "refused to comply further with their contract to maintain the depths of eighteen feet in the channels for a period of four and a half years, and, by their failure, the winter of 1858–9 passed without any work being done upon the bars." Having failed to secure by contract a continuation of the work, "the department was forced to resort to a contract for the use of steam dredges and appliances, and its officers are now, for the first time since 1839, with a remnant ($70,000) of the appropriation of 1856, conducting the operations of deepening the channels. The plan used is that of stirring up the bottom of the channel during the river flood, and leaving the current of the river to carry it seaward to deep water. It is one that has been successfully tried." Again he says: "It must be borne in mind that the channel requiring excavation in the Southwest Pass, is not less than a mile and a half in length; that the average depth of excavation for a channel eighteen feet deep is not less than three feet; that although the shoalest part of the bar is very soft to the depth of one, in some places two feet, yet below that depth the bar is tolerably stiff; and that, for a channel of twenty feet, the average depth of excavation is five feet, more than three feet of which is in tolerably stiff material; and the very stiff, tenacious mud-lump formation, occupies much of the channel-way near the outer crest of the bar."

In reference to the plan of deepening the channels by the construction of jetties on the bars, the captain has made the following remarks in his report: "The experiments made by me demonstrate that this plan is based upon correct principles, and is in accordance with the law under which the bars are formed. It is probable, however, that the plan of stirring up the bottom is the more economical of the two. The plan of jetties has not been tried at the mouth of the Mississippi to a sufficient extent to show whether it would be effectual or not, for

the contractors merely built one insecure jetty, of a single row of pile planks, about a mile long, on one side of the channel; whereas the board of 1852 recommended two jetties, each fourteen and a half feet wide, composed of piles two feet apart, one on each side of the channel, each five miles long, if stirring up the bottom and dredging should fail. It has been tried, however, at the principal mouth of the Rhone, a delta river like the Mississippi, and has effected the desired increase of depth. The plan was adopted by the French government after a full discussion of the whole subject by the engineer in charge of the work."

In regard to any material changes having taken place as to the character of the passes of the Mississippi during long intervals of time, the report of the Board of Engineers, consisting of Captain Latimer, United States Navy, and Majors Chase, Barnard, and Beauregard, of the United States Engineers, made October 28, 1852, says that "the board do not find evidence to confirm the opinion that any deterioration has taken place at the Southwest Bar. The survey recently made by officers of the Coast Survey exhibits fully as much water as existed at the time of Talcott's survey, (in 1838,) and the personal examinations of the board give the same result; and if at any period in this interval there has been reported to be more water than now exists, the board believe the fact may be accounted for by extraneous and not natural causes. * * * * * * The board, in their inquiries, found no reason to believe that this pass has, since anything has been known of it, changed materially its character or its depth, and they think they find reasons for this permanence of character, which will be stated hereafter. But the board, though having little fear of a sensible or rapid deterioration of this pass, are nevertheless of opinion that it is not adequate to the existing and prospective wants of commerce; and it is this inadequacy, and not its deterioration, which has now made it necessary to look for some efficient means of deepening this or other passes. * * * * * * The Southwest Pass takes from its origin a course of southwest by south, and it pursues it with little deflection to its bar. Though throwing off several small bayous, it exhibits no tendency to divide; and to this uniformity in its course, and maintenance of its volume, the board are disposed to attribute the permanence of depth upon its bar, for the pass presents no evidence of having ever carried more or less water than at present through its channel; and there is no evidence on record to induce them to believe that as far back as the discovery of the country there was less water on its bar than now. That it was not noticed or used prior to having the aid of steam for ascending the river, may be attributed to the superior facilities of ingress and egress from the eastward offered by the Southeast Pass, and by the fact that the prevailing winds from north round to southeast are adverse in this pass, while they are most favorable in the other." For further information relating to the improvements of flats and rivers, reference may be had to the annual report, 1859, of Captain A. W. Whipple, corps topographical engineers, upon the public works at St. Clair flats and St. Mary's river. The above extracts will apply equally well to the improvements in the character of the bar at the mouth of the Coquito caño of the Atrato.

The work at the latter place should always be carried on during the flood of the river, as the force of the current is at such times sufficiently great to throw the fresh water of the river across the Gulf of Darien; opposite the mouth of the Coquito, the width of the latter is about five and a half miles. A large quantity of the water flowing out of the main river through the Caños Urabá and Taréna, and also through the Caño Coco Grande, together with that of the Barbacoas, provided the ship canal cut is made from that point, may be diverted to the use of the cut by a judicious application of jetties; this, however, does not seem advisable, nor is it deemed necessary, as the immense quantity of water brought down by the Atrato is amply sufficient to meet any extra demands made by such improvements. Whilst, however, on the subject of this open cut, and the necessary changes in the character of that portion of the river, care must be taken to avoid any new causes of injury either to the channel above the locality of the works or at their site. A perfect knowledge of the localities of the river, and of its different changes, must be acquired, and then the experience and genius of the engineer, rather than rules and general considerations, must guide to a suitable solution of them. The amount of excavation necessary to open a cut from deep water in the gulf to deep water in the Barbacoas, by the Coquito, is 955,000 cubic yards; the estimate for completing the necessary improvements at the mouth of the Atrato may be safely placed at $500,000, based upon the cost of practical and successful operations on the Mississippi.

A little west of south from the mouth of the Coquito, and about nine miles distant, is a considerable indentation in the gulf shore line, forming a commodious bay; it is well protected from the north winds and has the best water for a safe and secure harbor. Within two and three miles to the north of it are mouths of the Caños Pichindicito, Pichindí, Pedrito, Urabacito, and Urabá, all subdivisions of the main Caño Urabá, sometimes called Leon; the latter, for the greater part of its length, is a broad, deep caño, as is evident from the numerous channels into which it divides itself near the gulf coast. From the representations of Trautwine and others who examined it, it must have an average width of one hundred and fifty to two hundred and fifty feet, and a safe mid-channel depth of twenty-five feet at low water until near its mouth. A cut made from this point to deep soundings in the bay referred to above may, upon a more thorough examination, prove a more preferable plan than that proposed at the Coquito caño. "For larger vessels than those contemplated in my survey," says Trautwine, "I am confident that this would be far better than to use Caño Coquito, and possibly it is so in any event." By this selection the effect of the prevailing winds from the north will not be felt; from the course of the cut, they will not be able to set directly or obliquely into its entrance, and will not, therefore, force the currents from the gulf in or from one side of the cut to the other, thus forming bars and middle grounds. From the proceedings of the Royal Geographical Society of London, at a meeting in April, 1856, during a discussion of this canal route, Mr. Robert Stevenson, F. R. G. S., in the course of his remarks, said that the engineering difficulties did not seem to him to be serious; * * * * that the great

difficulty appeared to him to be in making a good entrance into the Atrato. At the entrance of that river vast quantities of mud had been deposited, and a delta of great extent formed, inclosing a series of lagoons, through which no permanent channel is maintained; and this is the case of all rivers that fall into a tideless sea. The success of the scheme would, therefore, depend on forming a good entrance into the river, for this artificial communication would be necessary. He had no means of judging of its feasibility, but would assume that it was feasible on the statement made him."

PROPOSED SHIP CANAL CUT CONNECTING THE ATRATO RIVER WITH THE PACIFIC OCEAN.

By reference to the general map of the geodetic survey between the river Atrato and the Pacific Ocean, it will be seen that the general course of the Truandó, from its mouth up to the foot of the Palizadas, a distance of over twenty-three miles by the meanderings of the river, is very nearly parallel to that of the Atrato. The survey of the latter above the junction of the Truandó was carried on for several miles by one of the assistants of the engineer party; from the upper limit of his work to a point twenty-two miles above Boca de Sucio its course has been sketched from a map accompanying the report of Trautwine. Throughout this distance the channel retains its average depth and breadth. A straight line drawn from near the lower extremity of the Palizadas, where the general course of the Truandó makes a very considerable bend to the north, across the Lagunas, and perpendicular to the general direction of the Atrato, is only 32,000 feet, about seven miles and a half in length, and strikes the latter river at a point twenty-two miles above the village of Boca de Sucio. Let this be the initial point, or the summit point, as it shall be herein designated, of the line of the proposed canal cut determined upon after a careful examination of the results of the recent survey. Let the first section follow the projected line referred to above, across the Lagunas to its intersection with the Truandó; the second section connects this last point by a straight line with the head of the Palizadas; the third extends in a direct line to the foot of the Saltos; the fourth in a curved line to the head of the Saltos, including a tunnel of 800 feet through the Sierra de los Saltos; the fifth leads directly to the mouth of the river Grundó, a tributary of the Nercua; the sixth leaves the valley of the Nercua at the point, by a straight line, perpendicular to the axis of the Cordilleras de los Andes, and, after piercing the mountains with a tunnel 12,250 feet in length, continues on to the mouth of the Chuparador; the seventh follows for some distance down the valley of the river Paracuchichí, and, lastly, the eighth strikes in a direct line for the Bahia Ensenada or Estero de Paracuchichí.

The line proposed by Mr. Kennish differs very materially from the one just described; it leaves the Atrato at the mouth of the Truandó, and follows the meanderings of the stream to its junction with the Nercua; it then ascends the valleys of the latter and of the Hingadór, and strikes across the mountains to the Pacific. The length of the cut by his plan is stated in his report to be 56.08 miles, but the last

survey proves that it must be much greater. The length of the new line proposed is 43.2 miles by measurement from the plot of the survey. By continuing down the Truandó to its mouth, instead of taking the short cut from the foot of the Palizadas to the Atrato, the length would be about 63 miles.

The probable profile of the line adopted has been very carefully considered, and is represented below on the general profile of the surveyed route between the Atrato and the Pacific. By taking the mean velocity of the Atrato above the mouth of the Truandó to be equal to that below, an arithmetical proportion gives thirty-two feet as the elevation of the summit point above the mean level of the sea. This elevation is used on the profile drawing, and is the same as that of the point of intersection of the canal line with the Truandó. The latter fact is a strong proof of its correctness, as the two rivers below these points flow through the same flat country for nearly equal distances before uniting, and should, therefore, have about the same fall. The elevations of those points of the profile along the Truandó to the mouth of the Grundó are the results obtained from the local survey. The heights of those between the Nercua and the Pacific, however, are deduced from the actual line of levels measured across the mountains between the Hingadór and Totumia. It must be borne in mind that the instrumental survey was conducted over the most disadvantageous and unfavorable ground for the canal project, following along the trail selected by the Indians, over the highest ridges and driest portions of the soil, a route that could be traveled and found passable at all times during both wet and dry seasons. The angles of elevation measured to different points of the mountain profile from stations on the line of survey, both through the valley of the Nercua and from the Pacific coast, as well as the results of general observations made upon the physical features of the country, render the fact very apparent that there is a considerable falling off, or a great depression of the Sierra, towards both the valleys of the Grundó and of the Paracuchichí. It is to be greatly regretted that circumstances prevented the party from gaining more minute information concerning the valley of the Paracuchichí, and of the transversal passes leading from it through the mountains into the valley of a large tributary of the Truandó, which flows in only a few miles above its mouth. As this river has more than twice the quantity of water possessed by the Nercua, it is highly probable that a still more favorable route can be found leading out from its valley above the junction. From the maps it would seem that the distance from its waters to the Pacific is much shorter, owing to the configuration of the coast, than by any other line. An examination of the geological profile shows that from the Atrato to the foot of the Saltos the soil is mostly alluvial, excepting some little argillaceous rock between the Rio Salado and the Falls, which is in a more or less indurated slate, and which can be easily worked. Along the Saltos of the Truandó, the rock is volcanic, possessing all the requisite properties of durability, hardness, and strength, somewhat difficult to work, but will furnish good stone for the various purposes of the engineer. From the head of the Saltos to

the eastern mouth of the tunnel, the alluvial soil again covers a bed of argillaceous rock. The boring of the tunnel will be through conglomerate rock. From the western terminus of the tunnel to the ocean, both conglomerate and volcanic rocks appear, and also great beds of alluvium. The geological appendix, with its profile map and descriptive table of specimens, furnishes all desirable information in relation to the quality of the rocks.

By measurement, the length of the proposed cut is 43.2 miles; its width is 100 feet at the water surface, and its depth throughout 30 feet It is not intended that the slope and profile of the canal shall remain constant along its whole length, but it is designed, when within a few miles of the Estero, to assume a different slope from that first adopted, by making a break in the plane of the bottom. This is explained below, with the advantages to be derived from the alteration. It will be found that the slope at the water surface of the canal, the immediate cause of motion, will not be materially affected, whilst a great reduction of rock and earth excavation will be made. The summit point, at an ordinary stage of low water, is computed to be 32 feet above the mean level of the sea. The first of the two slopes adopted for the canal is constant from this point to the western terminus of the great tunnel, the longitudinal section of the surface of the current being a right line from the summit point to where it pierces the plane of the western head of the arch of the tunnel, with a fall of 32 feet in 43.2 miles, or the same as that of a line drawn from the summit point to the mean tidal mark on the coast at the termination of the canal. The second of the two slopes is from the point where the line of the first pierces the western head of the tunnel to low tidal mark, and the bottom line of this section of the canal is parallel to said slope at a depth of thirty feet. It will at once be seen that the amount of excavation of both rock and earth will be considerably less than if the datum slope line had been drawn from the summit point at once to the low tidal mark, instead of to the mean tidal mark, for the greater part of the length of the cut, and then making a break in it; and it will be shown that this break will scarcely cause any increase in the velocity. In making a choice of the figure of the canal to be adopted, attention should be paid to the fulfillment of those objects which are of the first importance in its construction. The expense and maintenance are two subjects which particularly call for consideration. The sides should have sufficient slope not to cave in, but not to such an extent as to greatly increase the expense of excavation; some artificial means can then be applied to protect them. To be sustained, without retaining walls, the slope of one perpendicular to two base has been generally used, but, in the case under examination, the slope of one perpendicular to one base has been taken for the reasons mentioned in discussing the cut between the Barbacoas and the Gulf of Darien. The cross section of the canal through alluvial soil is of a trapezoidal form. Where, however, there is no danger of caving in, such as excavations through rock or tunneling, the cross section is always of nearly a rectangular form.

Having determined upon the length, depth, breadth, fall, and cross sections of the canal cut, the next problem to be considered is the *mean velocity* of the current through a cut of the dimensions proposed.

In the concluding remarks of Mr. Edward W. Serrell, the consulting engineer of Mr. Kennish's proposed canal scheme, he says that "it is worthy of especial notice that the mouth of the Truandó is situated relatively to the Atrato and the two oceans, within a very short distance of where, theoretically, it would be best to leave the Atrato river to enter the Pacific." A few lines further on he adds that, "in the present location, (Kennish's location,) by the way of the Truandó, the descent to the Pacific from the confluence with the Atrato being about eqnal to the descent of the Atrato to the Atlantic, and the distance being essentially the same, the current on both sides of the summit would be about equal, excepting the effect of the rise of water in the Pacific, which will oscillate in the open cut, and flow to the lagoons near the summit level."

As the elevation of the mouth of the Truandó has been found by the geodetic level survey to be 25′.73, instead of about 15′, according to Kennish, and the length of the Atrato below the mouth 75.25 miles, instead of 63 miles by Kennish, it is to be presumed that the mouth of the Truandó is not situated near the locality which Mr. Serrell has theoretically fixed upon as the "best to leave the Atrato river for the Pacific."

By using the same formula, or one almost exactly coincident, for computing mean velocities of canals as that used by Mr. Serrell in ascertaining the elevation of the mouth of the Truandó, it can be demonstrated that the summit point of the proposed new cut, instead of the mouth of the Truandó, is the one from which "the current on both sides of the summit would be about equal," that is, that the velocity of the current through the newly proposed canal cut will be nearly the same as that in the channel of the Atrato. Let the surface current line be drawn from the summit point to the mean tidal mark, or the slope of the canal have a fall of thirty-two feet. The latter, it will be remembered, is the elevation of the summit point at an ordinary low stage of water above the plane of reference or mean level of the sea. This fall takes place in the distance 43.2 miles, the length of the canal. It will be the mean slope between flood and ebb tides.

Take the formula generally in use, $v = f\sqrt{\frac{s}{p}\cdot\frac{a}{l}}$; then $v =$ the velocity; f, the constant of friction, $= 90.9$, the latter being applied for the most regular and uniform beds; the width at the water surface being 100′, and the depth 30′, the banks having a slope of 45°; the area of a cross-section $s = 2{,}100'$; the wetted perimeter $p = 125'$; the latitude $a = 32'$, and the length 43.2 miles, $l = 228{,}100'$. By substituting these respective values in the formula the value of v, the velocity of the channel in the canal cut, is found to be 4.413 per second, or 3.01 miles per hour. The value of a, the elevation of the summit point at ordinary low water in the Atrato, was taken at 32′; now take the case of extreme high water, the same rise as measured at Boca de Sucio, and found to be about 10′.77 above average low water, and the altitude of the summit point will then be 42′.77. Substituting this value for a in the formula, and the velocity is found to be 5,101 per second, or 3.48 miles per hour, which must be the maximum velocity in the cut during the highest freshets of the Atrato. By referring

back to the pages on the velocity of the Atrato, it will be there seen that the mean velocity of the Atrato at a low stage of the river was 3.06 miles per hour, and during the highest freshets 3.68 per hour. The mean velocity in the canal cut at a low stage of the Atrato is therefore less than that of the Atrato under similar circumstances, and the mean velocity of the canal cut during freshets in the Atrato is still considerably less than that of the Atrato at high water. This fact may surprise those who seem to entertain a dread of selecting a higher point for the summit than the mouth of the Truandó. Figures prove that it can be safely done. The actual velocity will be found in reality to be less than the computed, especially in a tropical country where the growth of aquatic plants is so spontaneous.

D'Aubuisson's Hydraulics, in speaking of the Canal de l'Ourcq, furnishes some remarks in this connection worthy of attention. M. Girard, the engineer who planned the canal, "has observed, with reason, that aquatic plants growing always upon the bottom and berms of the canal, augment very much the wetted perimeter, and consequently the resistance. He remembered that Dubuat having measured the velocity of water in the canal (du Jard) before and after the cutting of the reeds with which it was stocked, has found a result much less before clearing." There can therefore be no objection to the selection of the summit point twenty-two miles above the village of Boca de Sucio; on the other hand, it is a very great advantage. The amount of excavation is very much reduced thereby, and the expense of construction consequently diminished. The length of the canal is also reduced, and its course more direct; the time of passing through would be less, and the wear and tear not so great.

Before closing this subject of velocities let the effect of the change in the slope of the bottom of the cut be considered. By examining Table I, containing columns of heights and distances above the mean level of the sea, used as a plane of reference, it will be seen that the limit of last tidal mark along the Totumia is 6,000 feet above its mouth, and was found by spirit level to be 2′.05 above the plane of reference, or 3′ below high tidal mark. The total tide on this portion of the Pacific coast was a little less than 10′ at the time of the survey, and Kennish reports that the tidal wave oscillates 12′.06 at spring tides. The flow of the tidal wave is considerably diminished by the current of the river. The descending fresh water is met by the flood tide when it commences to pour in, and the latter forms a species of dam to prevent the farther descent of the former. Until the ocean attains a greater height than that of the accumulated river waters, it cannot flow up. The opposite courses of the flow of the two waters, and the difference in their specific gravities, create a great many eddies and counter currents, which are of more or less importance in proportion as the volume and velocity of the antagonistic forces become increased or diminished. The waters of the sea rise and fall twice in each consecutive interval between the returns of the moon to the upper meridian; twice in a little over one day. The interval between two successive high tides is a little over half a day. It therefore takes six hours to pass through the total tide, three hours to fall from mean to low tide, and three hours to rise from low to mean tide. The progress of the tidal wave creates a current, the rate of the flow varying within

very considerable limits. Some of the most remarkable currents are found to be from 1'.5 to 14'.5 per second. The slope of that section of the canal cut between the western head of the tunnel, where the break in the plane of the bottom is made, and the low tidal mark is 0'.7 to the mile, the length of the slope being seven miles. To reach its summit would therefore require the inward flow of the tide to be at the rate of 2½ miles per hour; (that would be about 3'.4 per second, much less than what would be the maximum current throughout the entire canal in time of a medium water stage in the Atrato,) during the three hours it takes to pass from mean to flood, and then not to be impeded by any obstructions. The condition of non-resistance cannot be found, however, to exist in practice, as there would be a strong opposing force in the volume of fresh water 100' wide by 30' deep, which courses down the canal cut with a velocity the maximum rate of which it has been previously shown cannot be less than 4'.413 per second. On account of this influence of the descending fresh water with the upward flow of the tidal wave, the hours of the flood and the ebb tides along the canal are retarded in proportion as the distance from the sea increases. An inward flow into the cut at the above rate, and for a distance of seven miles, would be an extreme case, as has been shown by the Totumia, where the effect of flood tide is only felt 6,000 feet from its mouth, reaching a point still three feet below the level of flood tides, as shown by the instrumental survey. Should the observer, previous to the hour of flood tide, notice the tidal wave, it will be seen to flow inland and up through the cut, which would necessarily produce a retardation in the velocity of the descending fresh water current; later, at the return of the tide, when it begins to fall, although perhaps the effect of the change would not be instantaneous or perceptible, still the velocity of the channel in the cut would gradually commence to increase, passing from its minimum state until it reaches a mean condition at mean tide. As the tide continued to ebb, the velocity in the cut would, apparently, during the three hours of falling, constantly increase in theory, but not so in practice; for long before the effect of this increase could be felt at the summit of the break the turn of the tide would take place, and the flow of the flood tide would be again transmitted back into the cut, thus causing by its antagonistic action the velocity of the canal current to become gradually less and less. Even though there was no such reaction, the velocity would not become too great for navigation.

Mr. George Rennie, F. R. G. S., said, before the Geographical Society of London, that "with regard to the effect of admitting water into the canal, either from the Pacific Ocean or from the Atrato, he had no apprehensions; for the length of the canal between its junction with the Pacific at Paracuchichí and with the Atrato was so great, and the oscillation of the tide at either end so small, (notwithstanding they were high and low at different periods,) that before the water of a spring tide in the Pacific could have any effect upon the water in the canal, the velocity of the water would be so retarded by the friction and resistance of the sides and bottom of the canal, as to reduce the inclination of the surface of the water (in the canal) to three inches per mile over the whole distance of the Truandó part; but before the

water of the Pacific reached the further extremity, the tide would have fallen; and thus the two opposing forces of the pressure of the water without, and the canal within, would be reduced to an equilibrium. At three inches per mile, the motion of the water is scarcely perceptible." By the proposed cut from the summit point, the fall of the canal is a little over seven inches per mile. In theory, the heads of the velocities of the two antagonistic forces of tides and river currents are dependent upon this fall; but in practice the resistance of the sides and bottom, and the increased wetted perimeter caused by the growth of aquatic plants, very considerably diminished their strength and influence.

SUPPLIES OF WATER FOR THE CANAL CUT.

The ship canal cut is intended to receive, in great part, its waters from that great resevoir, the Atrato river, through an open entrance. It will in reality become a river aqueduct, as it is termed by Mr. Kelley, and very similar in its characteristics to the caños of the river forming its mouths. In examining the case of canals of open entrance, the following article appears in D'Aubuisson's Hydraulics: "Water, on its entrance in an open canal, forms a fall, its level being lowered for a certain distance; then it is elevated a little by light undulations, beyond which the surface takes and maintains a form very nearly plane and parallel with the bed, its slope and profile being always considered as constant. The velocity is accelerated from the top to the foot of the fall; it then diminishes during the elevation of its surface, and soon after its motion continues in a manner sensibly uniform." The velocity of the canal current will, therefore, not differ materially, on account of the open approach, from the computed results. Although the bottom of the canal will be considerably above the bottom of the reservoir, (the Atrato,) on account of the greater depth of the latter, still the portion of the banks of the river remaining below the cut can be shelved off, so as to give the approach a funnel shape, whilst at the same time the water surface of the canal would always remain continuous with that of the river. In order to obtain from the resevoir all the water deemed necessary for the canal, certain rules are laid down for the widening of the approach and the form of it, the limit of all being influenced by the expense. As before stated, the experience and genius of the engineer, rather than rules and regulations, must guide to the solution of all problems which may arise, and care must always be taken, lest some permanent injury be done to the channel of the river. The length of the Atrato above the summit point is over two hundred miles. Throughout this distance, the river drains an immense valley, which is nothing more than an extended marsh filled with numerous lakes; its volume of water is sufficient in itself to supply the entire consumption of the canal, without perceptibly interfering with the navigation of the river itself. Other sources of supply are found in the Lagunas, through which portion of the cut is made, and also from the Salado, Truandó, and Nercua, and other smaller tributaries. All of these are conveniently located by *nature for* feeders, and need but some necessary improvements for

guarding the mouths by masonry and sliding gates, so as to admit or shut off their waters at pleasure. It is impossible to approximate towards the quantity of rain which falls incessantly for nine months in the year on the eastern slope of the Cordilleras, and over the broad valleys of the Atrato, Truandó, and Nercua; but it is well known that this section of country is favored with a greater abundance of rain than any other part of the globe. Owing to the want of the necessary data, founded on accurate observations, no calculation can be made of the quantity of water available for canal purposes; but there is no doubt that the supply would be amply sufficient to maintain, at a proper elevation, a ship canal, through which to float ships of the greatest tonnage.

Mr. Beardmore, F. R. G. S., in his remarks before a meeting of the Geographical Society of London, asks the question, "Whether such a communication would be likely to reduce the level of the Atrato to a serious or injurious extent;" and goes on to deal with it by assuming "that the Atrato had at present as much as four inches fall in any or every mile of its course." The late survey gives about five inches mean fall per mile. Continuing on, he says, that "the river was evidently one of very large volume, and liable, from the character of the mountains draining into it, and from the excessive rain fall of the climate, to heavy floods; its width was therefore great, and its depth varied from forty-five to eighty-five feet. Assuming, then, that it were possible to abstract sufficient water to reduce the surface fall to a minimum of one inch per mile, (a flatness rarely to be found,) the depth at the junction would only be reduced about ten feet, and the power of discharging its waters would be reduced fifty per cent.; or, in other words, one half of its entire volume would be available to fall through the new cut towards the Pacific. But it must be remembered that, as the height of the Atrato at the junction was reduced, so would the velocity down the new cut be decreased, and therefore it would not in reality carry off any such proportion of the volume. These statements are matters of well-known fact in the science of hydraulics, being consequences of law that, *cœteris paribus*, the velocity and the discharge of any river vary as the square root of the rate of fall." He concludes his remarks by the following words: "There were, however, most important engineering questions, touching the especial manner of leading away the new line of navigation from the natural river, which could only be decided by the most careful surveys, and would depend on the amount and rise of flood waters; and the nature of the soil and valley at the position considered as being best adapted to meet the various contingencies of so important an engineering and geographical problem as the formation of an interoceanic ship canal."

AMOUNT OF ROCK AND EARTH EXCAVATIONS AND CUTTINGS THROUGHOUT THE PROPOSED CANAL CUT BETWEEN THE ATRATO AND THE ESTERO DE PARACUCHICHÍ.

The following table defining the limits of the various sections into which the work along the proposed canal most naturally divides itself; their respective lengths; the nature of the excavations, whether earth

or rock, and the quantities expressed in cubic yards to be removed, has been carefully computed and recomputed by the assistants on the survey—Messrs. De la Camp and Schmitt. The plan of the survey and the probable profile of the projected canal line, have both been carefully studied in order to determine upon the most feasible route; the geological profile by the geologist, Mr. Schott, has also been closely and attentively examined, that the quality of the soil and rock might be correctly ascertained. Throughout the different sections the banks, where the cuttings are through earth, have a slope of 1 perpendicular to 1 base; where they are through rocks, the cross sections of the cut have nearly a rectangular form. The width of the canal has been taken at 100 feet at the surface of the water with a depth of 30 feet in the channel. As in part of one section and the entire length of another, it has been found more advantageous to resort to tunneling, the height of the proposed tunnels has been taken at 100 feet above the water surface, which will allow any ship to pass through with her topmast and topgallantmast struck; steamers could pass without altering any of their gear. No estimate has been made for turn-outs to enable vessels to pass each other in the canal; it would be an unnecessary expense, as alternate days could be used for passing backwards and forwards; the operations of the electric telegraph might be usefully employed in directing their movements to and fro; but little time would be lost by detention, as steam tugs could tow them through in a very few hours. Owing to the elevation of the mountains over the tunnel section, the expense of sinking working shafts would be very considerable; there will be but little necessity for using them, as from the immense size of the tunnel it can be driven from either end by a large force. In case it is necessary to push forward the work more rapidly than by executing it in that way, it will be necessary to sink two or more shafts, and connect them with the excavations at each end by a heading; the tunnel then can be gradually enlarged, the excavated earth being raised through the working shafts, and at the same time carried out at both ends. Mr. Serrell suggests that the excavations might be worked in terraces, commencing a quarter of a mile apart, and which could be carried forward in regular lifts of five or six faces each. As far as the labor in the tunnel is concerned, it may be carried on day and night, and during all kinds of weather. The form of the cross section depending upon the nature of the soil, in this case, therefore, being rock, the sides will be nearly vertical, and the top in the shape of an arch; the arch roof may be left unsupported, as the cut is made through unstratified rocks. From Appendix A, in which Mr. Schott, the geologist of the expedition, makes some hypothetical remarks upon the geognostic structure of the country, the following extract is taken: "In regard to the probable degree of development, and the respective extent of each of the strata constituting the Isthmus, we are not able to go beyond certain conjectures, especially so in respect to its western portion. So far as sedimentary strata are concerned, a proposed cutting through will meet with no serious obstacles, whilst at the same time this section will furnish choice material for building purposes. Calcareous rock may be expected almost to a certainty within the bounds of the tertiary

and secondary formation, whilst the quaternary, and alluvium in general, will readily furnish plastic clay and clean drift sand. Heavy rocks for foundations and cyclopean work generally will be furnished by the trappean series. Material of this kind may be found of every degree of hardness and gravity within the limits of the Sierra de los Saltos—that is, from the foot to the head of the Truandó falls. The geognostical distribution of this rock, however, deserves more consideration, on account of the additional force which would be necessary in working through this mountain dam. Nevertheless, the shistose nature of this rock would assist greatly, not only in blasting, but in laboring with the pickax. A pretty close estimate for the work of excavation through the trappean strata, could easily be made by computation, taking in account the angles of dip and strike, and as a base line the distance measured through the formation at the Saltos. On the oceanic divide, however, this rule could not be applied, because rock of this kind was only seen on the western foot of the low Cordillera, and we have therefore nothing to base any theory upon. We do not know to what extent the trappean rock may be developed as a nucleus of this divide. If this rock, however, should have risen to any considerable height under the tertiary cover of this low mountain dam, traces of it ought to have appeared to the sight at or near the crossing of the little river Chupepe. This not being the case, we believe the trappean beds to be rather subordinate in the orographical structure of this western Cordillera."

The labor of tunneling the Cordilleras for 12,250 feet is truly an herculean task; but when the importance of the work is considered, and the great interest at stake to the whole world is calculated, it falls into insignificance alongside of the laborious and expensive improvements which have been carried on by single States alone. In this instance, we have not a single State or country, but the world, to furnish the means and the will to undertake the greatest problem of the age. The labor, once completed through the mountain section, will be a durable monument of man's enterprise for all ages to come. Nothing short of a volcanic eruption, or the opening of some fathomles abyss, could ever efface it from the surface of the earth. The most difficult sections of the work, where time and money and a certain amount of hard work are alone needed, will be the most enduring. There the climate is favorable for the laboring classes, and the material is at hand for comfortable dwellings. Provisions for their support, after one or two years, can be supplied in great part from the valleys of the Nercua, the Paracuchichí, the Juradór, and the Totumia. The idea that it will be necessary to maintain them entirely on provisions imported at most extravagant cost, is a fallacy almost too transparent to need refutation. Good roads for wagons and pack mules can also be made through the valleys and over the mountains, from the Rio Salado across to the Pacific.

The most tedious and uncertain excavations are those from the head of the Palizadas to the Atrato. By a judicious distribution of labor along these parts, they can be executed without the floods of a day destroying the work of weeks, notwithstanding the whole country should be inundated during nine months of the year, as stated by some

writers. The latter is a somewhat large percentage of time to be allowed for any interruptions of the kind, considering the statement as regarding inundations is merely hypothetical, without actual observations and positive information to base it upon. One may doubt whether this difficulty will prove so great. The velocity of that part of the Truandó not being very great, advantage must be taken of the river floods to carry off a large surplus of material removed from along its bed. The immense vegetable growth already existing along the line of any cut that may be made, with the aid of certain artificial appliances, will prove a great protection to the banks, and prevent any great injury to them from freshets. Throughout the Palizadas, the country is, in a strict sense of the term, inundated, but not to the extent that is generally understood by the use of that expression. The waters rise even with the top of the banks, and then, by numerous gullies, spread out to the depth of a few inches over an immense flat country extending back from the river. The dense undergrowth impedes very much the velocities of the currents of these drains, and makes them comparatively harmless. This was the case whilst the engineer party was at the first camp on the Truandó, established in the midst of the Palizadas. As heavy a rain fell at that time as in all probability ever fell before or since, for it came down in sheets of water. A good system of drainage should be adopted for disposing of such superabundant rains. From the foot of the Palizadas to the Atrato the cut is through a series of lagunas. This section is very similar to the delta formation at the mouth of the Atrato, and the same remarks regarding the necessary improvements at the one place are applicable to the other. Before concluding the subject, it may be remarked, that from the mouth of the Truandó up to the foot of the Palizadas, the river is already navigable for small steamers, drawing from four to five feet water, and of greater draught if necessary; some few logs and some overhanging timber only require removal. If a cut should then be first made through the Palizadas, or around them, the river would become navigable for the same class of boats up to high ground near the mouth of the Salado. Besides, it would open a larger, more direct, and better channel through which to drain the upper country, than that now offered by the thousand and one intricate, narrow chutes through which the waters find their way. At the very commencement of the work, a small steamer could be transported in sections to the gulf, and afterwards put together in deep water of the Atrato. By lighters it could be loaded from vessels anchored in the gulf, through the Caño Coquito, or any other more preferable one, and thus steam communication be had at once from the mouth of the Atrato to the foot of the Palizadas. The cut through the latter completed, it could extend to the mouth of the Salado, from which point a good wagon road can be made to the Pacific ocean. The canal section has been taken sufficiently large for ships of the heaviest tonnage, as it would be the cause of very great regret if the works were to be undertaken on too small a scale, for in works of this description the expense will be found not to augment proportionally with the breadth and depth of the water channel. No estimates are included for a canal with one or two locks, as they were not called for by the Senate in

their resolution, although the quantity of excavation would be considerably diminished, and the consequent expense. As an offset to the latter, however, would be the increased cost of a large quantity of additional masonry, to say nothing of the large sums required for the making and transportation of the immense iron lock gates that would be required in such an event.

The following table shows the computed amounts of rock cuttings, earth excavations, and tunneling, for each section, and also the sum total for the entire length, fifty-two and two thirds miles, of the projected interoceanic ship canal :

Computed amount of rock cutting for each section, and for total length of the projected Interoceanic Ship Canal

No. of section.	Terminating points of section.	Length of section.	Earth excavation.	ROCK EXCAVATION. Clay rock.	Conglomerate rock.	Volcanic rock.
		Feet.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*	*Cubic yds.*
I.	From Bahia, Ensenada, or Estero de Paracuchichí to Rio Paracuchichí...	6,950	797,100			
II.	Along Rio Paracuchichí to mouth of Chuparadór	13,200	697,100	....	2,202,900	323,200
III.	From mouth of Chuparadór to western entrance of tunnel	16,900	438,400	....	12,534,100	
IV.	Great tunnel through the Cordilleras de los Andes	12,250	....	Tunneling	5,245,700	
	Extra cutting	....	1,500	....	1,000	
V.	From the eastern mouth of tunnel to Rio Grundó	13,600	19,351,900	7,451,500		
VI.	From Rio Grundó to head of Truandó falls	23,350	22,524,500	9,616,800		
VII.	Along the Truandó, including tunnel of 1,000 feet through Sierra de los Saltos, near the large falls at Observatory Hill, to point near the foot of Saltos	10,450	....	....	....	6,577,300
	Tunneling	....	....	....	....	352,300
VIII.	From foot of Saltos to mouth of Rio Salado	20,200	8,424,000	4,476,500		
IX.	From mouth of Salado to head of Palizadas	30,850	11,847,000			
X.	From head of Palizadas to point where the projected line crosses Truandó river before leaving it	40,200	8,436,000			
XI.	From Truandó river, across the Lagunas, to Atrato river	32,050	2,740,600			
		228,100	75,258,100	27,544,800	19,983,700	7,252,800

The whole length, from the Pacific to Rio Atrato, 52⅔ miles; total excavation, 151,300,100 cubic yards

By comparing the preceding table with the "table of recapitulation" of the amounts of soil excavation, and rock cutting, for a canal 200 feet in width by 30 feet in depth, presented by William Kennish, Esq., along the route proposed by him as the results of his survey, or rather reconnoissance, and which was found to differ very materially in profile and plan from the geodetic survey under the direction of the topographical engineer of the late Atrato expedition, it will be seen that the total excavation of earth and rock for a canal only 100 feet in width by 30 feet in depth, by the route adopted by this officer, is exceeded by the sum total of the other by 22,421,640 cubic yards. Whilst this is the case, a further examination also shows that the amount of rock cutting, however, is less by 52,066,980 cubic yards than by Kennish's—the width of the one cut being twice that of the other. The following is a rough estimate of the cost of the total amount of excavations: the cost of tunneling, including the heading, can be placed at the very fair rate of $2 50 per cubic yard; that of ordinary rock cutting at $1 50 per cubic yard; and that of earth excavation at thirty-three cents per cubic yard. These prices are larger than those deemed sufficient by Mr. Serrell in his summary of the estimated cost of the canal. The following figures will show approximately the cost of this portion of the work:

Nature of work.	Cubic yards.	Cost per yard.	Total cost.	Cost per yard, adopted by W. Serrell.	Total cost by Mr. Serrel's prices.
Earth excavation	75,058,100	$0 33	$24,835,173	$0 33	$24,835,173
Rock cutting	43,183,300	1 50	64,774,950	1 00	43,183,300
Tunneling	5,598,000	2 50	13,995,000	2 00	11,196,000
Sum total	104,049,400	....	103,605,723	....	79,214,473

HARBOR AT ESTERO DE PARACUCHICHÍ—HUMBOLDT'S BAY.

The Estero de Paracuchichí is a narrow inlet, extending for several miles between the main shore and a long narrow peninsula, "La playa de Paracuchichí;" the western end of the canal terminates in this inland bay. Although narrow and not deep, still it is a most excellent natural harbor; vessels can lie there at anchor in perfect safety, and not be exposed to the force of either winds or waves; the peninsula really constitutes a "permanent breakwater," as Kennish calls it.

The surface of the bay is perfectly smooth, and is crossed daily by the natives in their small, frail canoes. The bottom consists of soft mud and sand, which can easily be dredged with buckets; a sufficiently commodious harbor may be had in a short time, by deepening the inlet to any required depth, without much labor or expense. The soundings are represented, by those who made them, to vary from twelve to fifteen feet in mid channel, and its width was found by measurement to be 750 yards. At present, it is connected with an

outer bay, called Humboldt's Bay, by a pass through a long line of breakers; the rude bungo, in her trips from Panama, safely enters the Estero through them, either with her sails set to a good breeze, or when impelled rapidly forward by oars. At low water, the bar at the pass becomes almost dry from the peninsula to the main shore south of the mouth of the Paracuchichí. From information gained through the natives, the bungo is of the same description as those used on the Atrato, and the trip is made in perfect security; a shipwreck on the coast is an occurrence which very seldom takes place, and goes to demonstrate the stormless character of the Pacific, where severe gales seldom occur. Humboldt's bay is an open roadstead, and reported to possess good anchorage ground, the bottom being of sand, and deepening gradually from the shores outwards. The waves break upon the beach in long continuous lines of surf, which are more formidable in appearance than in reality; a boat with sufficient headway can pass safely through them; they are said to be a common feature to the Pacific coast of South America. The bay, as previously described in the Descriptive Memoir, terminates on the north at the promontory of Punta Ardita, and on the south at that of Punta Marzo; a line drawn between the headlands is over thirty miles in length, and the perpendicular to it, from the crown of the bay, is about fifteen. The greatest difference between flood and ebb tides, at the time of the survey, was not quite ten feet; during spring and neap tides, it may be two or three feet, more or less.

The waves have never been known to wash over the peninsula, and no indications of drift show that the ground was ever inundated; it stands as a natural breakwater against the force of the waves.

Humboldt's bay is in reality a portion of Panama bay, the southwestern point of the latter, as before remarked, being nearly on the same parallel of latitude as the village of Zambos.

In order to complete the line of canal communication between the Atrato and the Pacific, it is necessary to connect the Estero de Paracuchichí with Humboldt's bay. It is proposed to do this by a cut from the former across the peninsula, and then by building out in its prolongation, from the shores of the latter, jetties to form a passage through the surf into deep water of the ocean; the depth of the cut between them will have to be sufficient to allow for the swells of the latter, at least from thirty-five to forty feet below low tide.

There are no difficulties in the way of the execution which cannot be overcome; but, as at the mouths of rivers, and in passes between the open sea and any inward gulf, depositions of shingle or of sand will accumulate at their heads, caused by the currents along shore, and the diminished velocity, on account of the works, of the flow of the ebbing tides. To obviate this, the Romans built their jetties in a series of piers and arches; the Dutch employed the system of sluices, combined with the benefit of the scouring power of the tides; but the French ascertain the amount of sand annually brought, and remove it by dredging. An artificial harbor of small extent might be formed, by enlarging the area between the jetties. Certain rules have always to be adhered to in their construction, both regarding their plans and cross sections, and the space inclosed between them. The plan of each

jetty is generally curved; the distance between their heads depends upon local causes, but the best authorities say it should not be less than three hundred feet, and, under the most unfavorable circumstances, need not be more than fifteen hundred. As Mahan remarks, "there are certain winds at every point of a coast, which are more unfavorable than others to vessels entering and quitting the harbor, and to the tranquillity of its waters. One of the jetties should, on this account, be longer than the other, and be so placed that it will both break the force of the heaviest swells from the sea in its mouth, and facilitate the ingress and egress of vessels, by preventing them from being driven by the winds on the other jetty, just as they are entering or quitting the mouth. The cross section and construction of a stone jetty differ in nothing from those of a breakwater. * * * The head of the jetty is usually made circular, and considerably broader than the other parts, as it in some instances receives a light house and a battery of cannon. It should be made with great care, of large blocks of stone, well united by iron or copper clamps, and the exterior courses should moreover be protected by fender beams of heavy timber, to receive the shock of floating bodies."

The form of the cross section found by experience to be the best adapted to this purpose, is that which was used in the construction of the boldest and most gigantic work of the kind—the breakwater at Cherbourg; in those last constructed it is still adhered to. The same author says that the "experience of many years, during which this work has been exposed to the most violent tempests, has shown that the action of the sea on the exposed surface is not very sensible at this locality, at a depth of about twenty feet below the water level of the lowest tides, as the blocks of stone forming this part of the breakwater, some of which do not average over forty pounds in weight, have not been displaced from the slope the mass first assumed, which was somewhat less than 1 perpendicular to 1 base. From this point upwards, and particularly between the levels of high and low water, the action of the waves has been very powerful at times, during violent gales, displacing blocks of several tons weight, throwing them over the top of the breakwater upon the slope towards the shore. Wherever this part of the surface has been exposed, the blocks of stone have been gradually worn down by the action of the waves, and the slope has become less and less steep, from year to year, until finally the surface assumed a slightly concave slope, which, at some points, was as great as 10 base to 1 perpendicular. The experience acquired at this work has conclusively shown that breakwaters formed of the heaviest blocks of loose stone, are always liable to damage in heavy gales when the sea breaks over them, and that the only means of securing them is by covering the exposed surface with a facing of heavy blocks of hammered stone carefully set in hydraulic cement." The same remarks apply to the construction of the jetties for the proposed passage from the ocean into the peninsula cut. As the materials for their construction are found so conveniently at hand, and as a very large force of laborers can be employed at the same time, the two jetties can be pushed rapidly forward from the shore, each portion being properly secured and completed as the work

advances, as it is indispensably necessary to cover the courses of masonry by the succeeding ones as rapidly as possible, so that no serious damage can be done to the work by the force of the waves. The materials used are either loose rubble stone, solid masonry bedded in hydraulic mortar, or caissons filled with bêton. More stupendous works have been successfully executed of the same nature and under more difficult circumstances, and it would seem to be simply absurd for any one to hypothecate a failure upon a mere unfounded opinion. If a single nation can undertake vast improvements for the protection of one of its commercial harbors, why cannot the engineering skill of the day cope with the difficulties, even though they were mountain high, of constructing an artificial passage from the waters of an immense ocean into those of a natural, land-locked harbor, the terminus of a ship canal which is to benefit the whole civilized world?

Besides the roadstead of Cherbourg, the works of Plymouth, Cetté, Brest, Buffalo, at the mouth of the Delaware, the formation of the port of Niecueve Diesson on the Texel, and the harbor of Algiers, may be cited as illustrations of what improvements have been constructed by different commercial nations. The estimated cost of the Pacific harbor improvements can only be roughly computed; judging from the cost of works of similar construction, a fair and liberal estimate would be about what Mr. Serrell has placed it in his table of cost.

In presenting the following summary of the estimated cost of the projected canal between the Atlantic and Pacific oceans, including the improvements at the mouth of the Atrato, earth excavations, Pacific harbor improvements, and all the necessary appurtenances for constructing an immense work like the one proposed, the estimates for many of the accessory items have been taken from those adopted by Mr. Edward W. Serrell. This gentleman acted in the capacity of consulting engineer during the first discussions of the plans and cost of the work, which were based entirely upon the results of the survey by Mr. William Kennish; the verification of the labors of the latter was the object of the late government expedition. The estimates of Mr. Serrell are to be found in the pamphlet by Frederick M. Kelley, Esq., styled "The Union of the Oceans by a Ship Canal, without locks, *via* the Atrato valley."

Summary of the estimated cost of the canal and appurtenances.

Object of expenditure.	Prices assumed by Lt. Michler for excavation and tunneling.	Prices assumed by Mr. Serrell for excavation and tunneling.
Works at the mouth of the Atrato	$500,000	$550,800
Earth excavation	24,835,173	24,835,173
Rock cuttings	64,774,950	43,183,300
Tunneling	13,995,000	11,196,000
Pacific harbor improvements	1,150,000	1,150,000
Light-house	35,000	35,000
Piers	25,000	25,000
Depots on Pacific	50,000	50,000
Depots on line and hospital	35,000	35,000
Depot at junction	15,000	15,000
Executive department	120,000	120,000
Engineer department	375,000	375,000
Medical department	80,000	80,000
Pay department	90,000	90,000
Commissary department	120,000	120,000
Quartermaster's department	135,000	135,000
Dredging machinery	350,000	350,000
Hoisting and pumping engines' machinery	875,000	875,000
	107,560,123	83,220,273
Add 25 per cent. for contingencies	26,890,031	20,805,068
	134,450,154	104,025,341

Comparison of estimated costs according to different surveys and authorities.

Authorities.	DIMENSIONS OF CANAL.		Remarks.
	200 ft. in width, and 30 ft. deep.	100 ft. in width, and 30 ft. deep.	
Serrell, by Kennish's survey.	$157,907,042		See report of a ship canal by Kennish & Serrell, of 1855.
Serrell, by Kennish's survey.		$73,687,141	See Mr. Kelley's pamphlet of 1859, "On the Union of the Oceans."
Lt. Michler's survey at Serrell's prices.		104,025,341	See Lt. Michler's report.
Lt. Michler's survey, according to his own estimate.		134,450,154	See Lt. Michler's report.

The above table is a comparison of the estimated costs of the canal according to the dimensions proposed at different times, based upon the results of private surveys made under the patronage of Frederick M. Kelley, Esq., by Mr. William Kennish, and that by the engineer party who were sent out by the United States government to verify those surveys.

CONCLUDING REMARKS.

In the development of the great resources of the United States of America, the people are not content with the advantages lavished upon the country by nature, but they exert every effort and employ all the appliances of art and science to increase the usefulness of that wide extended system of interior navigation of lakes and rivers, which unite in inseparable bonds the various sections of the country. Constant progress is made towards the connection of navigable rivers, rivers and lakes, and large cities. These latter, almost the growth of a day, are separated by the broad expanse of prairie, and by high mountains, but the energy and skill of man have annihilated both time and space between them. It is scarcely necessary to cite among the most remarkable means of communication, those railroads which now cross the Alleghanies. They can compare in energy and difficulty of execution, and per haps are more deserving of admiration, than the roads over the Simplon and Mount Cenis.

The use of canals was known in Egypt, China, Ceylon, Italy, and Holland before the Christian era. It would be difficult to determine in what country and during what epoch they were first introduced. The first canal constructed in France was that of Languedoc, which was completed in 1681; the first in England was finished in 1760; and the first in the United States in 1802. Since then, rapid progress has been made towards the advancement of this system of internal improvements in the latter country. The prodigious length of the American canals astonishes the world for their greatness, and surpass any in Europe in that respect. Look at the Erie canal, the first in America, and one of the greatest in the world. Great roads have also been undertaken, such as the national and the northwestern turnpike of Virginia, built with great care and at great expense, but which have had to succumb to the march of still greater and more wonderful improvements. And now the hope is encouraged that a most important step will be taken towards uniting more closely the nations of the world, by one unequaled in magnitude and importance, that of an interoceanic ship canal through Central America. A very few years have elapsed since the project of a railway across the Isthmus of Panama was treated as chimerical, yet it is now in full operation. It is scarcely within the power of man to estimate the great difficulties of such an undertaking in the fullest extent, nor to anticipate their character and the means to overcome them; but "where there is a will there is a way" to cope with and overpower them. After all, man is but an agent in executing those grand schemes of civilization which the Great Ruler of the destinies of nations in His wisdom ordains and directs. Aside from all prejudice and interest, every one must see and admit not only the importance of such a work towards accomplishing the ends of Providence, but must acknowledge its feasibility and future success.

An accurate geodetic survey of a line across the country *via* the Atrato and the Truandó, has been made. The result of it, after careful examination and study, has convinced the officer in charge of the

engineer party of the practicability of the enterprise. This survey is valuable in a geographical point of view, if in no other, for it corrects many egregious errors which have already been published to the world, and will guide explorers in any future examinations through that most interesting portion of New Granada.

If the report of the late government survey, now submitted for perusal, can even partially prove to the different commercial nations the possible feasibility of connecting the two oceans by a canal, it will have accomplished all that it would wish to do. They now have reliable information in reference to the country, and the little that is known may be an incentive for seeking for additional knowledge. If the results, when laid before competent engineers, should prove the problem to be impracticable, something still has been gained; the question then would no longer be surrounded by uncertainties, but a quietus would be put upon the subject forever.

There are many matters which have not received any attention in this report; the many advantages which would accrue to the world have been so faithfully and strongly portrayed in the pamphlet by Mr. Kelley, on the "union of the two oceans," that it becomes really a natural accompaniment or appendix to it. The attention of those who are anxious to examine more fully into the subject is referred to the careful perusal of the foregoing pamphlet, which will be found accurate and extremely interesting in its details, Much additional information can be gained by reading the pamphlet containing the reports of Mr. Kennish's first survey, and the accompanying remarks and deductions by Mr. Serrell. Their reports being sufficiently full and correct as to the kind of labors and materials needed, as well as the opportunities of obtaining them and their statements generally upon the subjects of the different engineering, commissary, quartermaster, medical, pay and executive departments, being of interest, it has not been deemed necessary to dwell upon them to any extent in this already too lengthy report.

It is to be regretted that the publication of the report has been so much delayed, but the want of means prevented its appearance. The report of the Navy officer, not having that difficulty to contend against, and not having the same rich field of material for examination, has been completed for some time. It would be most agreeable and advisable that a commission of competent engineers should examine the results of the late survey and report upon them. The officer in charge of the topographical survey desires the strictest scrutiny of his work, and would most respectfully call the attention of the War Department to this recommendation. Not one nation, but all, should join in the enterprise.

The United States, England, France, Russia, Prussia, Holland, and Spain, all have great interests in the Pacific and Indian oceans. Let them all, therefore, make a combined effort and unite in the construction of what will prove the most magnificent work of the nineteenth century, a ship canal, without locks, connecting the mighty waters of the Atlantic and Pacific oceans.

VII.

REPORT ON THE PHYSIOGRAPHY OF THE ISTHMUS OF CHOCÓ

BY ARTHUR SCHOTT, NATURALIST AND GEOLOGIST.

WASHINGTON CITY, D. C., *June* 1, 1859.

SIR: In compliance with your orders, I have the honor to submit to you the following general report, with the accompanying appendises on the physiography of the Isthmus of Chocó, in the vicinity of the seventh degree of north latitude.

I remain, sir, respectfully, your obedient servant,

ARTHUR SCHOTT,
Naturalist and Geologist of the Expedition.

Lieutenant N. MICHLER,
Corps Top'l Eng'rs, U. S. A., in charge of Top'l Survey, &c.

The country upon the Isthmus of Chocó, of which a recent topographical and physiographical survey has been made, though falling altogether under one climatic head, may nevertheless be considered under a subdivision of sections, according to their respective elevations above the level of the ocean, or to their facing different meteorological regions.

The hypsometrical relations of the country appear but little developed, and are simply reduced to one or perhaps two ranges of an apparently unilateral upheaval of crystalline strata, more or less thickly overlaid by the deposits of quaternary clay and alluvium. The highest ridge, not exceeding 1,000 feet, does not reach beyond the tropical zone, which in this latitude maintains a vertical elevation of 2,500 feet above the salt waters.

However low this cordillera may appear, it is still of great importance as a hydrographical and also as a meteorological divide. The whole region is situated under that remarkable belt of perpetual atmospheric oscillations, both aqueous and electric, and consequently exhibits a most gorgeous development of every class of organic forms.

The flora consists of an unbounded diversity of genera and species, and is characterized by the predominance of the following orders, as Palmaceæ, Gramineæ, Musaceæ, Marantaceæ, Liliaceæ, Aroideæ, Piperaceæ, Orchidaceæ, and a most varified series of leguminous trees, shrubs, and vines. A very prominent feature in the floral physiognomy of the country is produced by a rich display of Filices and Lycopodiaceæ. Especially the former furnish throughout the country an eloquent proof of the hyetographic state of their respective

tation. The distribution of this interesting class of plants in : character as terricolæ, saxicolæ, and dendricolæ, is certainly to draw the attention even of general travelers.

ther orders of plants, either by their scarcity or non-occurrence, fy to the hygrometric state of the atmosphere, as, for instance, Cactaceæ, of which only one or two species have been found, or the iferæ, which in vain have been looked for.

bservations on animal life, which in one section is represented but multitude of equals, and in another by an increased diversity of ra and species, lead to similar conclusions. Some ethnographical statistical data may also enable the explorer here to complete his ch on the physiography of the country.

order to give a clear idea about the land between the two rocky iers or capes of the generally iron-bound coast which forms the on about the west end of the proposed ship canal route, we have ate that this acccessible portion of the coast is the gift of three rs. These, though of little magnitude, carry constantly sufficient r to prevent a final closing up of this combined fresh water issue he heavy tidal beat of the ocean.

he hydro-topography of this inclosure between Punta Ardito, to north, and Punta Marzo, to the south, exhibits the following con-ration; under cover of the former cape the river Juradór empties she sea, sending at high water one branch southward into a long, r-shaped, slightly curved bay, which, near its lower end, at a nce of about ten miles, receives the waters of another small river, ing the name "Totumia or Tutumia." Below the mouth of the r this narrow bay connects with another of larger dimensions and open towards the ocean. This latter bears the name "Hum-t Bay;" its width is about twelve miles from opposite the mouth e Totumia to Cape Marzo. The inner narrow bay is called by natives "Bahia Ensenada," which means the "Ingulfed Bay." topographical structure of the country will be more readily under-l by an analytic table of its various sections heading a more de-d description.

'ACIFIC SIDE:

1. *The Coast.*
   a. The Beach.
   b. The Mangrove belt.
   c. The Alluvium.
2. *Dip of the Cordillera.*

ATLANTIC SIDE:

1. *Strike of the Cordillera.*
   a. The Table Lands.
   b. Sierra de los Saltos.
2. *Alluvium.*
   a. The Palisades.
   b. The Lagoons.
   c. Lower Atrato.

3. *The Coast.*
   a. Atrato Delta.
   b. The Mangroves.
4. *Gulf of Urabá.*

I. Pacific Side.

1. *The Coast.*

a. The Beach.—The Bahia Ensenada separates a similar shaped peninsula from the colluvial main, to which both the bay and the neck of land bear a strict sinuosity. The peninsula is called Playa de Paracuchichí, which means the beach of Paracuchichí. This name is derived from a third and much larger river, shedding its waters opposite the south point of the peninsula into Humboldt Bay.

The beach of Paracuchichí seems to consist entirely of littoral sand, fragments of shells, corals, and others marine deposits, scarcely rising more than eight or ten feet above high-tide mark. It is covered by a sort of a vegetable high-tide mark, cresting the peninsula with a dense growth of shrubbery, small trees, arborescent bushes, and certain forms of littoral grasses. The whole, which is almost impenetrable on account of the prevailing number of trailing creepers and vines, is outwardly lined by an almost unbroken row of lofty cocoa palms, among which two varieties (perhaps species) are represented.

A small settlement with a population of Zambos, (half-breed of Indians and negroes,) by nationality ex-pirates, escaped convicts, wreckers, and perhaps other more harmless adventurers by trade, is scattered along the inner side of the peninsula, their land and water-locked borough.

The heavy surf beating against the outside of the Playa de Paracuchichí seems to explain the entire absence of fucoid growth along this peninsula, and also the scanty deposition of shells.

The "Bahia Ensenada," with an average width of about 600 yards, separates the peninsula from the main land, which is easily entered through the mouth of the Totumia.

b. The Mangrove Belt.—In entering and ascending this river, a mangrove region, most magnificently developed, receives the traveler. Its width, from its borders on the bay to where the tidal marks become obliterated, may be set at one mile and a half.

Nowhere on the Atlantic or Pacific coast have we met with a rhizophorous tree vegetation of such magnitude. The truly gorgeous net work of roots for miles and miles, all around, appears like an arched foundation upon which the mighty colonnades of the straight growing mangrove timber are reposing. Here we notice single trunks, of from two to three feet in diameter, bearing graceful crowns of a light green foliage, at a height of about 100 feet or more.

The aspect of this almost unbounded labyrinth of roots, grasping upon a bottomless layer of soft brackish mud, bears some analogy to zoöphytic life, with the difference only, that corals are built from the *bottom upwards*, whilst the roots of these trees, in an opposite direc-

tion, ramify downwards through the bottom. Both, however, are employed by nature to conquer the waters. The height of the mangrove roots above low water mark may be considered as a tide gauge, which here shows about eight or nine feet between the two tidal extremities.

After passing the last traces of tide on the banks of the Totumia, a fertile alluvial tract of land closes in. Its cross diameter is comparatively inconsiderable, and its upper limits soon seem to lose themselves in the recesses of little mountain valleys, which open towards the low lands.

c. The Alluvium. The ground densely covered by a heavy tree vegetation, appears frequently interspersed with rich patches of Musaceæ and Marantaceæ, which seem to indicate a natural ability of the soil for those easy agricultural pursuits peculiar to the tropics, and in following them the inhabitants of Paracuchichí have made a fair start. Several more or less extensive rozas (clearings) for the cultivation of plantains, yam, yuca, rice, and other minor garden vegetables, border the river banks on both sides.

2. *Dip of the Cordillera.*

The alluvial soil, however, soon loses its depth in approaching the foot of the mountains. Thick and irregularly deposited quaternary layers of sand and clay, underlying the former, come to sight. The frequent interspersions of drift wood, beds of fallen leaves, and even pebbles, prove the powerful *sweep* to which this region occasionally must be subjected. One or two miles higher up—that is, from three to four miles above the mangroves—the bed and banks of the river are strewn with boulders of crystalline rocks of every size. Here vegetable development reaches its perfection. The elevation of the ground above overflow, though with an abundant drainage of fresh water, together with the general favorable conditions of a tropical climate, seem to have produced such a result. From three to four different species of palms, and so many ferns, associated with an endless variety of endogenous and exogenous vegetable forms, confirm the prolific character of the soil.

Where the first rocks (in situ) on the banks and in the bed of the river make their appearance, the mountain slope in the strict sense of the word commences to rise. The distance from here to the Playa of Paracuchichí is about five miles.

The wood lands covering the Pacific slope of the dividing ridge are of a very monotonous aspect. The quaternary clay and tertiary strata overlaying the crystalline metamorphosed rocks, are heavily burdened by a dense cover of tropical woods, which almost entirely excludes all ventilation and insolation.

A well beaten Indian path leads through this dark vegetable ocean along and across the Upper Totumia, the Pié de Nercua, the Chupepe, and the Chuparadór. The latter closes the series of Pacific affluents on this line. The zigzag line of our toilsome march through these wilds runs after the Indian fashion, constantly over the crests of the hills

and mountain ridges, descending only occasionally in order to pass from one interlocking spur to another. The distance from the upper limits of the alluvial belt to where the Pacific and Atlantic waters divide, may be set at about three miles. This distance, however, under a reduction of all its vertical and horizontal circuits upon a straight base, may be shortened for almost two thirds, and even more.

The average ascent from the level of the ocean to the point of highest elevation, at about 900 feet, gives approximately 2.100.

The only real rock on this section of our route was seen in the bed of the Totumia, and near the mouth of a small tributary of the Pié de Nercua. Both were of a similar lithological character, and belong to the doubtful family of trappean rocks, being composed of a predominant ingredient of augit or hornblende, and having a crystalline granulate texture. They are occasionally interspersed with crystals of glassy felspar (?) and quartz.

From the Pié de Nercua, semirock was only met with where some stream had laid it open to sight. Thus, at the ford of the Chupepe, a small tributary of the Paracuchichí, a thin and isolated stratum of a grayish blue clay was found, underlying the usual red and yellow clay which almost universally forms the overcoating of the surface throughout the country.

The stratum on the Chupepe appeared but imperfectly indurated, and was ranging east and west, with a slight southerly dip down the river. Its entire thickness did not exceed two feet.

Circumstances beyond our control forbade all thorough investigations into the geognostical features of the country, so we had to be content with what nature had favored us to that end by means of aquatic or terrestrial denudation.

In regard to collecting, I had to limit myself almost entirely to hasty field notes, and a few select specimens of geology and cryptogamic botany.

The fauna, of which we had anticipated to see far more of the prominent forms peculiar to this latitude, appears to have confined her treasures within certain groups to nature's highways, like running streams and occasional openings bordering the river banks.

Mammals were found to be rare; birds seem to be less so. The principal orders were Scansores and Conirostres, among which the entomophagous members apparently prevail. Of the reptiles, Sauridæ, but more particularly Anuridæ had the lead. No class, however, was more fully represented than the insects, especially those of prey, together with the wood and fruit destroyers.

Botany furnishes some interesting data by a number of Filices and Lycopodiaceæ, and especially by a numeric display of palms, of which from four to six species and genera have been noticed. Besides these, the well known diversity of endogenous and exogenous plants peculiar to the tropics could not be overlooked. Notwithstanding all this, the unbroken density of the country's vegetable cover, which nearly entirely excludes from its inclosures light and air, produces in the mind of the observer the sensation of an insufferable monotony, from which every one must become anxious to be relieved, the sooner the better.

II. THE ATLANTIC SIDE.

1. *Strike of the Cordillera.*

a. The Table Land.—The broad crest of the dividing ridge and also the upper portion of its Atlantic slope have in common the same topographical features with the western slope. The fauna and flora do not seem to undergo any material changes until the lower strike side of the Cordillera is reached. Here several new forms of fern were noticed making room for other members of this peculiar class of plants. Especially to be mentioned here are several samples of a beautiful tree-fern, (probably a cyathea,) which make their appearance near the head of the Hingadór falls, at a place called the Tree Crossing. This locality received its name from a giant tree which was thrown from bank to bank, where it now forms a natural bridge over the Hingadór. Here is the only locality along the whole line of our travel where tree-ferns occur. The discovery of these singular trees in a place of comparatively little elevation was quite unexpected.

The declivity of the Atlantic slope of the dividing ridge is very rapid, and shows an average angle of about 40° to the mile. Its alluvial and vegetable cover permits a closer sight into the geognostical structure of what is beneath the surface than it is possible to have on the other side. The latter exhibits an obtusely serrated profile, more or less peculiar to all shistose strata, whilst the strike side correspondingly falls off like a steep terraced abyss. Upon this side the Hingadór descends to the table land by a series of falls, the uppermost of which presented to the surveying party a sight of great beauty and impressive boldness. At the head of the falls the rocky walls were found to be overcoated with a light shady conglomerate of a cemented texture, and containing, imbedded in a calcareous matrix, coarse sand and gravel. Higher up, in one of the western head branches of this stream, a more consolidated semi-rock was noticed containing copiously interspersed fragments of little shells. This rockseems to be also impregnated with carbonate of lime.

The bed of the Hingadór shows near the foot of the falls another important feature in the shape of several thermal springs. The temperature of the latter, for want of proper instruments, could not be accurately measured, but some of the party passing by estimated it approximately to be from 105° to 112° Fahrenheit.

The area drained by the Nercua and the upper Truandó with their respective tributaries forms a table-land basin, which is bordered to the westward by the Cordillera just treated upon, and towards the east by the Sierra de los Saltos, which seems to range somewhat parallel to the former. The headwaters of both rivers remain still unknown to us, because lack of time and the inadequate means of travel and transportation did not admit of any deviation from the strictest pursuit of the principal object for which the survey was intended. The surface of these regions consists chiefly of quaternary strata, with a thick and most valuable cover of vegetable mold. Along the Nercua

underlying strata are nowhere exposed, and it is only below the junction of this river with the Truandó that occasional tertiary (?) layers and beds of indurated clay or argillaceous marl are met with. Though horizontally stratified, a loose structure and a predominant interference of vast alluvial beds, and above all, the irregularly disturbed position of the layers, justify the conclusion of their being but the broken up surface of an upheaved tertiary bed. Especially here we regret our unsuccessful search for fossil remains within the bounds of these strata, which would have enabled us to verify the real character and position of this geological section.

The scenic beauty of the country along the Nercua and upper Truandó is great, and attracts very much by its most cheering character, particularly when compared with the twilight stillness which enwraps the woods on the Cordillera to the west. Prolonged openings along the banks of these rivers, with a number of small tributaries, (rios and quebradas of the natives,) prove an increase of drainage when compared with the Pacific slope. Here, also, is found a considerable addition of plants, both numeric and generic, which undoubtedly is the result of the more favorable climatic conditions ruling over these regions. Also a higher developed fauna, with a characteristic and cheering increase of birds of every description, bears testimony to the higher qualities of the country. This character of amelioration seems to be particularly appreciated by a few Indian families, who, being of peaceable agricultural habits, have chosen this valley for their home. They raise upon some clearings by their own hands and near their substantially built huts, (tambos,) plantains, bananas, yuca, yama, maize, sugar-cane, and quite a number of minor garden plants. Besides these, there appear scattered through the woods some wild and spontaneously growing fruit trees and shrubs. Several forms of palms identical with those on the other side have been noticed; they bear the native names of Milpesos, Chontaduro, Pijiguai, Jipijapa, Palmiche, Coroso, Puertorico, Quitasol, Palma Amarga, and Murapo. They apparently belong to the genera Bactris, Martinezia, Areca, Aiphanes, and Carludovicea, Bixa Orellana, the Achiote of the natives, and a bread-fruit tree, "Membrillo," were also noticed. The latter has nothing to do with the bread-fruit proper, which is Artocarpus, whilst the one from this neighborhood seems to belong to the order "Lecythidaceæ."

Among the more prominent members of the fauna we mention a deer, of which but a single specimen was seen on the Nercua. The pachyderms are represented better by the two conspicuous forms of the tapir and a peccari, the Danta and Sajino or Sajeino of the natives. The latter may prove perhaps to be a different species from those which I have seen in Texas and Northern Mexico. Of members of the cat family we only found tracks, but often heard their cry at night, from which we conclude that there must exist here from two to three species. Of the gnawers or miners the Cavybara and Agouti, also from two to three species of Sciuridæ were noticed. There is also no doubt that the order of Quadrumana are also well represented. Of the dreaded vampyres and other homely chiroptera nothing was seen.

Among the birds, Scansores, Rasores, Columbidæ, and Conirostres are

conspicuous by their generic number and diversity in general, whilst some portly members of the Grallatores add to the peculiarity of nature's aviary.

The waters all abound in fish, of which quite a number of new forms attract the explorer's interest. This is also the case with reptiles, among which Sauridæ and Anuridæ seem to prevail against Ophidia. Alligators in great numbers infest the waters of this region; they, however, seem to be shy, and the natives exhibit but little fear before them. Our party had often to depend on the eggs of these large saurians, as also on those of the harmless iguanas.

In regard to its surface, a distinct declivity of the Nercua country seems to be proved by the hydrographical character of the two rivers, both the Truandó and the Nercua, which exhibit throughout a tendency to keeping collected their waters within one solitary bed. A number of cut-off bends, which were noticed along the banks, are attributable to the frequent but only local deposition of drift wood and floating brush work. These moorings often obstruct the current, not only temporarily, but they become permanently fastened down by the hold taken upon them by an excessively-growing vegetation, which almost instantly takes possession of such floating rafts.

The valley of the Nercua is also marked by a thermal spring which breaks through its right banks about four miles above its junction with the Truandó. The temperature of the water was measured and found to be 107° Fahr. The short distance of the thermal localities, in both the Hingadór and Nercua, being but about from five to six miles in a straight line, suggests that they are probably situated upon one volcanic focus, which lies parallel to the range of the western Cordillera, with no intercepting range between them.

If sublime grandeur or solemn reservedness characterize the landscapes on the Pacific side, the epithet of cheering opulence may be fixed upon the table-lands adjacent to the Nercua and the upper Truandó.

The nature of the gravel forming occasional beds and banks in both these rivers, is generally the same, with the slight difference that argillaceous semi-rock, nodules, and boulders of more or less indurated clay, appear to be pretty uniform in the Nercua, whilst quartose rocks, with a very considerable addition of chalcedony, hyalite, and other fossils of a similar nature, form a prominent feature in the Truandó gravel.

b. The mountain dam of the Sierra de los Saltos.—Close to the lower strata of the whitish indurated clay on the Truandó, a mountain torrent empties into the river from the left. A large depository of rocks, boulders, and pebbles before the mouth of this tributary, proves the powerful floods which must rush down here during the rainy season. This tributary is marking an important change in the geological features of the country, and as the natives could give no name for it, it was called "El Quebrador," which means the breaker, in allusion to its forming the westward limit of the vast bed of a "shistose crystalline formation, a bold upheaval of which constitutes the Sierra de los Saltos. This series of rocks forms the lowest

visible link of the orographical system between the Atrato and the Pacific. It firmly supports, like a dam, the uplands of the Truandó and Nercua, and guards them, in the shape of a gigantic levee, against the aggressions of the waters from the mighty Atrato. Through this sierra, then, the Truandó struggles for a distance of about three miles, forming a series of rapids, narrows, falls, and shallows, which defy every attempt at navigation.

The banks on both sides are crowned by bold, rocky, but densely wooded hilltops. The river itself, before reaching the head of the upper rapids, suddenly assumes a singular aspect. Its waters being collected in one broad bed of solid rocks, with a current suddenly checked by rocky barriers below, forms an uninterrupted chain of large ponds, through which the river descends in solitary gravity. The rocky bottom of the river gradually becomes visible, the waters grow shallow, the currents increase, and finally a turbulent play of eddies and breakwaters announce the head of the rapids. Here the banks and the bottom of the river are everywhere strewn with various sized boulders of silicious rocks, pure masses of quartz and chalcedony of every color, and varying in shade and degree of transparency. Some of these boulders were found sometimes loose, sometimes firmly imbedded in an iron-cast matrix of trappean rock, which is the principal constituent of the mountains. Of those silicious amygdaloid bodies, several were measured to be of from four to five feet in diameter.

One place at the foot of the first rapids, where the mountains on both sides reach their maximum height, was named "El Puerto," meaning a gap, or, literally, a gate. Here a little running stream comes in from the right, its bed showing a bold mountain break, which received the name of "Quebrada de Peña Alta," (ravine of the high ridge)—referring to the greatest elevation of the sierra in this neighborhood. From this place down, narrow falls and rapids follow each other in quick succession. Among them is the "Salto Grande of the natives," which does not, however, form a cataract, in the strict sense of the word, but only a narrow, though powerful chute of water, over an inclined plane from 700 to 800 feet in length, and with a fall of about 28 to 30 feet in that distance.

Near the foot of what is called the last fall, another not inconsiderable tributary rushes in through a break in the left bank. For the peculiar descent over three rocky terraces, characteristic of the formation before us, this tributary received the name "El Salteador," (the Jumper.)

About one mile below the lowest fall, or at the foot of the rapids, another tributary comes in from the left. Its mouth is barricaded by a mighty bed of large boulders, and rough gravel, similar to that at the mouth of the Quebrador. This lower tributary, also found nameless, was called "Pedernales," (stone creek;) as the Quebrador does above, so this creek forms the limits of trappean rocks below. From the mountain file of the Sierra de los Saltos, several specimens of rocks have been taken, and were all found to belong to one and the same family of trappean strata, of which mention has already been made, when speaking of the little river, Pié de Nercua, on the Pacific side. These rocks all vary very much in external appearance,

and also in texture, though they maintain at the same time certain characteristics in common. As such, we consider their crystalline texture, whioh is often rough and granular, often smooth and glassy; also a certain pseudo cleavage, similar to that of other shistose rocks, which, like the specimens of the Sierra de los Saltos, is often scarcely traceable, but often again quite distinct, and finally a dark, grayish green color, which, in all probability, is caused by augitic ingredients. The outside of all these rocks, when water or weather-worn, becomes dark and lead-colored, at the same time smooth and shining, as if varnished with some plumbaginous preparation. Of four specimens, the specific gravity was found to range between 2.43 and 2.75.

These beds of trappitic rocks have evidently, since their composition, undergone a considerable degree of metamorphosis; this possibly points to a state of submersion at the time of their protrusion, through the tertiary beds which border its slopes on both sides. In a few places where cleavage and substratification of these rocks were somewhat perceptible, the longitudinal axis of the sierra could be guessed at, showing a general bearing from S.SW. to N.NE. Where the river has forced its passage through the solid ledges of the rocks, its course approaches the same angle which the stratification forms across the longitudinal axis of the mountains.

Below the mouth of the Pedernales canoe navigation, temporarily interrupted by the narrows of the Sierra de los Saltos, may be resumed again, for the river there quietly runs through a transitory region, which, in its geognostical and generally physical character, is but a repetition of the table lands above. About three miles below, on the left bank of the river, and about half a mile above the mouth of the river Salado, another rock, not seen before, was noticed.

This rock, also sedimentary, seems to belong to a limestone series, and is of a saccharine texture, and probably by metamorphosis became crystalline. Other tertiary strata, which were mentioned above at the table lands, interpose in this neighborhood. Silicified fragments of shells are constituents of this valuable fossil. One of the specimens taken there in situ contains the mutilated impression of a shell, perhaps a mactra or cardium. Like its confederate strata of tertiary rock, this limestone appears in a disturbed position, dipping in an easterly direction.

These younger strata then form a sort of a sheath, between the forced edges of which the eruptive masses of the "Sierra de los Saltos" have risen. Thus we find the former accumbent to the latter in almost equal distances.

2. *Alluvium.*

a. The Palisades.—The Rio Salado, entering the Truandó from the left, is again a geological boundary mark; in its close vicinity, the rocky skeleton of the country becomes gradually deeply overlaid by mighty alluvial deposits. On reaching the great alluvial level of the Atrato, after passing the mouth of the Salado, a repetition of scenery, similar to the table-land region near the mouth of the Nercua, the Truandó exhibits a stately appearance. Its waters are all gathered

in one broad bed, and the stream winds along in wide, graceful bends, which are deeply overshadowed by a heavy vegetation of trees, and bordered by the impenetrable undergrowth of shrubs and vines, or they become occasionally lighted up by natural openings, densely covered with bright green patches of musaceous plants. The gigantically developed foliage of the latter stands out in bold relief from the dense felt, which is produced by an unbounded development of rushes, cane, and arborescent grasses.

In a botanical point of view, great similarity in genera and species was noticed here with those upon the table lands; only within the limits of the rocky portions an additional number of saxicolous shrubs and herbs was found.

The fauna through this mountain file appears to be still more fully developed, as likewise a greater diversity of species is perceptible. This, however, may be but the result of the topographical character of the country, by which animal life is compelled to convene more exclusively within the approaches of the river.

Equal causes produce equal results. Thus the still waters above the Saltos of the Truandó, like those below, are caused by natural dams obstructing the free passage of the river. These dams, however, are vastly different in nature from each other. The one above is formed by one of the hardest material geognosy employs, while the other is produced only by the more solid portions of vegetation, the bone and sinew of tropical growth, which, drifting by, become entangled and fastened down, thus forming natural wears of dead timber and living brush.

The surface of the country, by distancing the lowest vestiges of rocks, loses its declivity, and approaches the vast level of the alluvium of the Atrato. The velocity of the streams becomes lowered, and the soil, for want of a rocky skeleton, exhibits increasing infringements by their waters. Finally, we are in midst of a swampy forest region, which, bordering the foot of the table lands, still participates in the richest developments of tropical vegetation, but not without a marked decrease in its specific and generic proportions towards an increase of equals and plants of more gregarious habits.

The vegetable cover here becomes less and less accessible to light and air, the lower the country descends towards the Atlantic. Consequently, the physiognomy of the flora assumes another character. The soil is now not any longer the sole home of the plants; to maintain themselves upon the ground, they must become of more marshy or even aquatic habits. Those which are unfit to do so have to seek refuge upon the trunks of trees, where each family, according to its nature and necessities, finds its safe abode at certain elevations above ground. The peculiarities of certain orders and families of plants here becomes so strikingly marked, that observations to that purpose furnish an excellent scale of the hytographic state of the different strata of the atmosphere, overlying each other within the mighty inclosures of these tropical forests.

The tree vegetation here, however gigantic in its dimensions, exhibits a development of roots not in proportion to the growth over ground. In examining the growth of the roots of these low land plants, we

found the proportion of spongioles generally much larger than that of the true and principal roots. This apparent lack, however, in many instances is readily replaced by a vigorous growth of aerial roots, which, through this section of the country, becomes a marked feature. A striking sample of this kind furnishes one of the most common exogenous trees along the Truandó, and which bears the vernacular name, "El Trementino." This giant forester, though not furnished with aerial roots in the strict sense of the word, has the lower portion of its trunk formed into a very strongly ribbed cone from fifteen to twenty feet in height, with an entire length varying between 125 and 150 feet. The whole column does not emit any branches until it reaches a height of between 80 and 100 feet. This conical base, though not fasiculated into real aerial roots, as has been noticed frequently with several species of palms, assists in fastening the tree firmly to the ground, which latter, for the greater part of the season, is subject to be under water.

The want of branching trees in these forests is replaced by a great variety of dendricolous plants, which are either true or pseudo parasites. Among them, various Aroids, (Spadiceæ,) Lycopodiaceæ, Hepaticæ, and certain genera of fern maintain the substratum of the forest, whilst others, as Bromeliaceæ, some few Cactacæ Orchidaceæ, and different species of Filices and Musci, have their homes up to the highest portion of the forest growth. Others again being real vines and climbers, (Scandentes et Serpentes,) were found from the ground up to the tree tops, which they help to weave into a densely ramified mass. By the latter ventilation and insolation are almost entirely excluded, whilst at the same time the upper portions of tree vegetation are firmly fastened together. This is necessary for its stability, on account of the lessened development of the roots and the shifting and swampy medium they are placed in.

We have intentionally dwelt longer on this peculiarity of vegetable life, as it is fundamental to an understanding of the physical character of the surface of country. Death and regeneration are ruling through these forests alike vigorously. They here employ, however, somewhat different means for their purposes from what exist in other latitudes. It is, for instance, not a sudden gush of wind which brings down and finishes decaying tree giants, but, on the contrary, it is the subtile, scarcely perceptible increase of specific weight of such dead bodies, owing to their sponge-like, water-absorbing condition. Whenever this gravity reaches its maximum, trees of most enormous size break down under their own weight, producing, like an avalanche of the forests, a thundering crash through the otherwise unbroken silence of these regions. Travelers preparing to camp under the cover of such woods, may caution themselves against the danger of falling trees, like mountaineers do in the Alps, by effecting some shock of the air which readily brings down from the upper portions of the forest what is frail and prepared to fall.

To such ligneous detritus a host of living minor vegetable forms are clinging, not separating from their destroyed homes, even after the waters of the river have possession of them. Thus an incessant movement of driftwood and migratory plants is maintained, by which

means the soil is constantly worked upon and reared with its surface swamped or dry, and cut up into a multitude of islands and lagoons, bayous and sloughs, interlocking dams and bars.

The important office of the tree vegetation, in shaping the surface of this section of country undoubtedly gave rise to its popular name, "Las Palizadas," which, interpreted in this sense, means "fence works of the woods." We here apply this name, which by the people is fixed *par excellence* to one particular portion only, to the whole belt of swampy forests, bounded on one side by the foot of the Sierra de los Saltos, and bordering on the other the open lagoon lands of the lower Truandó and Atrato.

The fauna, ever corresponding to the character of the soil and its vegetation, upon which it depends, within the Palisades, exhibits a similar subdivision of forms. The large carniverous saurians of aquatic habits increase numerically, as also do certain pachyderms. Not only the Sajeino, but also the Danta (Pecari and tapir) increase in numbers, as is justly inferred from the more frequent paths made by them to reach the river. Of the water-loving miners or gnawers, the Agouti and the Cavybara, many signs have been noticed. Soil and mud at the same time are found thickly inhabited by a great variety of amphibiæ of every order, aquatic, terrestial, and dendricolous. Larger and smaller cats seem to be rare within the Palisades, as they then have to choose the dry season for their sports. Quadrumana and Sciuridæ appear to be more common, rarely descending, however, from the tree tops. Of insects, the water-born Diptera, as sand gnats and mosquitoes and Libellulæ, prevail in number, but are outdone in diversity by Coleoptera, Neuroptera, Hemioptera, Lepidotera, and generally all the members of xylophagous insects.

Arachnidæ, especially those of extraterraneous habits, seem to be very fully represented. Of bees, one or two wax-producing species were procured, as also a piece of their fabric, which, however, seems to be identical with the one known to exist in eastern New Granada, which is unfit, however, to be bleached. (See General P. C. De Mosquera's Memoria, sobre la Geografia Fisica y Politica de la Nueva Granada. Nueva York, 1852, page 39.)

In fishes, we never elsewhere witnessed such a diversified multitude of genera, species and individuals.

The physical condition of this section hardly permits permanent human settlements, and even the Chocó Indians, born and brought up among these woods, look upon the section of the Palisades only as a fishing and hunting ground, whilst they erect their dwelling huts higher up on the table-lands.

If the forest lands upon the Pacific slope of the Cordilleras have been characterized as of a solemnly reserved aspect, and the adjacent mangrove belt as of sublime grandeur, then this section of the Palisades should impress the mind like a stygian forest. The traveler from this subsylvatic region must turn his face towards the zenith whenever he wants to see higher organic forms, either animal or vegetable.

The hydrostatic condition of the Truandó makes, of course, a great difference in the appearance of the Palisade region. We had occasion to notice this at the time when the river with its tributaries was full

to the top of its banks, and again when it was below high water mark by from eight to ten feet.

The distance from the eastern to the western borders of the Palisades by the river is about eight miles, and from there through the transitory region up to the foot of the falls fourteen miles; the pass through the Sierra de los Saltos to the head of the falls and rapids is about three miles; the distance along the rivers Truandó and Nercua is about twenty-three miles.

b. The Lagoons.—If we have to consider the region of the Palisades as a real amphibious country—if this term is admissible—we may look upon that of the lagoons as a compound of miry vegetable lakes, more aquatic than terrestrial in its nature. It is, however, profusely studded with small islets or hummocks, diversely interwoven with the levees thrown up by its water currents. These are marked by a more or less stunted tree growth, which gives but a somber relief to the monotonous aspect to that green ocean formed by this region of permanent glades. On entering the lagoons the traveler has reached the level of the Atrato's overflow.

At low water this region forms a chain of lagoons connected one with another. It is also in every direction traversed by the eddying currents of the mother river and its tributaries, almost at a right angle to that of the Atrato; but on reaching the lagoons the opposing forces of both naturally press the former to an oblique course, which intersects the longitudinal axis of the Atrato at an acute angle. In this the lower portion of all the tributaries within the low lands of Chocó seems to participate as in the necessary result of the Atrato's uniform meridianal course. All the older Spanish maps concur in this potamographical feature of the country. In a region nearly nine out of twelve months submerged and under the sweep of an endless number of opposing water currents tree vegetation remains out of the question, except in a few favored spots which rise above the general level.

The scanty foliage of the trees appears often suppressed by an overburdening growth of Lichenes, Jungermanniaceæ Lycopodiaceæ, and a whole host of parasitic suckers in the shape of Orchidaceæ, Bromeliaceæ, Filices, Aroideæ, and others, which have taken possession of the withering trunks and branches of the trees. From their deathlike looking crowns wave the gray flakes of Fillandsia Usneoides, like the funeral streamers of nature. The greater part of this region, however, is covered by a thick graminaceous vegetation, here and there interspersed by other water plants, mostly Alismaceæ, Polygonaceæ, Pontederiaceæ, &c. Among the graminaceæ the most prominent position is given to the so-called "gramalote" of the natives (Panicum glaucum?) which on several occasions was found by measurement to have a subaquatic articulated growth of from 4 to 10 feet in length. It is usually associated with a plant called by the natives "tabaquillo" or "tobacco de aqua," which means water tobacco. The plant, however, belongs to an entirely different class, and seems to be identical with Polygonun hispidum, or nearly related to it.

Among the trees appears the water-loving Cecropia peltata, which bears the vernacular name "Guarumo," an Inga with eatable pods,

(the guamo of the natives,) a mimosaceous tree, with a graceful umbellate crown, and occasionally the Trementino, so called by the Atrato navigators. Palmaceæ appear to be very scarce throughout these everglades.

As by its vegetation, so also the lagoon region of the lower Truandó is strictly characterized by its fauna. Besides being an alligator home *par excellence*, its birds and mammals prove the thorough lacustric nature of the country. Of the latter Quadrumana and Edentata, represented by two forms only, have been noticed. Myctes seniculus and Bradypus tridactylus seem to be the only mammalians of this region. This singular representation by one of the highest and one of the lowest forms of their class is only effected by the dendricolous life to which both animals are limited.

Among the birds Grallatores, Rallidæ, and Ardeidæ prevail in absolute numbers and generic diversity. There appears among the waders that partly gallinaceous looking bird called cabrilla by the natives, (Chajuna Cavria;) also a most graceful little form, the Jacana of the Chocoés, (Parra Jacana?) General Mosquera mentions the same under the Spanish name "Chorlito Alcaravan." Among the very few Conirostres seen here a beautiful Tanagra was obtained. This little inhabitant of the lagoons seems to feed on the seeds of some aquatic plants, perhaps the millet-like grains of the gramalote. Three or four species of kingfishers (Halcyonidæ) connect here with real Zygodactylæ. They may be considered as aquatic scansores, as the Plotus (Anhinga) is a dendricolous pelicanid. The latter also is a very common bird all over this grassy ocean. Among the highest order of birds was a hawk. A post mortem examination after its capture gave evidence of its entirely aquatic food, the remains of shrimps being found in its stomach.

The lower Truandó loses itself in a network of small deltoid outlets. The principal one, however, winds along and meets the levees of the Atrato, and empties about one and a half mile above the mouth of the Rio Sucio, the latter entering from the east. The place where the main body of the Truandó enters the Atrato is conspicuously marked by an extensive "caymanero," a high sandbar, where the alligators hold their unmolested rendezvous for sport and airing. The provincial language fixes the above named to all such localities.

The "Boca Caymanero" of the Truandó is the uppermost, and carries the largest body of water. It is also bordered by more elevated banks than the others, these being more bare of tree growth. The fallen timber and drift wood, however, make navigation through the Boca Caymanero at low water more precarious. The heavy boats of our party, however, found a free passage through it, even after a prolonged dry season.

The distance traveled through the lagoon region is about eighteen miles.

c. The Lower Atrato.—The width of the Atrato at the mouth of the Truandó is about 1,000 yards, having an average depth of more than fifty feet. The current is strong, making it in some places a rather laborious task to cross over with a loaded boat; for a clumsy bungo it is almost impossible. On the other hand, northerly winds during the dry season often oppose the current of the river so violently as to pre-

vent any craft from floating down by itself. The open space formed by the wide bed of the river so fully admits these currents of air and light through the agency of which the high levees, crowned by a gorgeous tree vegetation, are formed. The latter is densely interwoven with the unbounded riches of a well insolated tropical undergrowth. The size of vegetable individuals and the dimensions of the groups composed by them, seem to be in strict proportion to the width of the river and its grandeur in general. This increase of vegetable development not only refers to bulk, but also to generical multiplication, both of which are again accompanied by a proportional increase of the fauna.

Every class of animals that may be sought for within the bounds of tropical lowlands, is fully represented by a number of types. Mammals, birds, reptiles, and fishes abound, and of each the higher and lower orders can be found. Thus were seen the Quadrumana, Cetacea, and Edentata. Among the birds, from the Accipitres down to Anatidæ, Pelicanidæ, and even Sternidæ have been observed. The series of reptiles and Amphibia is also complete. As to fishes, their orders and genera seem to correspond fully with those which came to our notice on the Truandó.

In regard to Articulata and Crustaceæ, a corresponding relationship seems to exist between them along the line generally.

Sucio is a small trading and shipping station upon the right bank of the river, a few hundred yards below the mouth of a little tributary coming in from the east, and which gives the name to this half breed settlement. On the opposite side, the northern branch of the Salaqui river, having joined a southern branch of the Truandó, enters the Atrato through an open site of canebrakes and swamps. The currents of all these affluents are like that of the mother river, very strong; and, like the latter, seem to prove that they all carry the largest volume of water within the smallest space, cutting deep, vertically walled channels through beds of yellow and lead colored quaternary clay, the formation of this section of the country.

From Sucio in a northwesterly direction, a range of low outliers of the Cordilleras of Darien is seen just touching above the horizon. These Lomitas, as they are called by the Spanish, bear the name of "Cacarica." This word undoubtedly belongs to the language of the Darien Indians, and is also given to a small river heading within their inclosures and emptying into the Atrato some short distance below the Sucio. The head of Rio Sucio (Muddy river) is to be sought for on a distant sierra, a little southeast from the village. This mountain range, which is a far detached outlier of the gold bearing Cordillera de Antioquia, is well defined in its outlines, and serves as an unmistakable landmark for the Atrato navigators. On the banks of the Sucio, several gold-washing stations are known, which regularly ship their annuities down the Atrato for the Cartajena market, besides a considerable supply of caoutchouc, ivory nuts, plantains, cacao, yams, and other articles of vegetable food.

On the other hand, the Sierra de Cacarica is an interesting geographical mark, showing towards west northwest that often spoken of depression of the Western Cordilleras, through which the late surveys have searched for an interoceanic canal route. The bearings of the

longitudinal axis of this sierra seem to have some relation to the Sierra de los Saltos mentioned above.

The locality of the village of Sucio rises but little above the general level of the Atrato banks. When the party visited it for a second time, about the close of the dry season, which, as we have been told by the people here, was one of the most constant ever known, the banks of the river measured, from the water edge to the top, from fifteen to eighteen feet.

The vegetation about Sucio, in comparison with the one just passed along the Lower Truandó, is especially characterized by three or four more different palms, and also by a number of "Filices." These two botanical families were scarcely observed through the region of the everglades.

From Sucio down for a distance of about ten miles, the course of the river is very tortuous. This is the result of intervening mountain and hill ranges upon the left side, where outliers of the Cacarica range approach nearer to the river.

Still farther below, on the concave side of a bend, one spot occurs where various sized erratic boulders are imbedded in the alluvial river bank. This detached deposit may be considered as the probable top of one of the firmer substrata underlying the bed of the river.

Some twenty miles below Sucio, the vegetation, heretofore of a marshy but terrestrial character, becomes gradually aquatic again, the levees occasionally vanishing beneath high water mark. Lacustric, stemless palms and exogenous trees of decided aquatic habit, as Cecropia peltata, the Dormidon, (a mimosaceous tree,) one or two Carolineas, a Cedrela, a Tecoma, a Cassia, and an Inga and other leguminous trees, are leading forms in covering the river banks, which appear overburdened by their gorgeous growth. This is alternately intercepted by patches of Musaceæ, Amomaceæ, gigantic Gramineæ, and a certain class of odd looking Aroideæ. All the bolder shaped forms are lined and festooned by a never ending chain of climbers and vines, belonging to most diverse botanical orders. Where the banks run out, forming low points round which the Atrato takes its solemn sweep, extensive emerald planes are formed by the dense hydrostatic growth of the so-called water tobacco, or tabaquillo, and the gramalote, the big grass of the natives, and often densily interspersed with the poisonous Caladium (arboræum?) Such patches extend often for hundreds and hundreds of acres, and often deceive the eye with a show of land. There is, however, upon them, no foothold for terrestrial animals, for even the long poles of the bogas, when pushing their heavy craft along, very seldom reach a firm bottom. Only the feathery tribe or lighter mammals of arboreal habits, as monkeys and the sloth, are found approaching such localities. They are, however, the delight for the sporting cayman, which, half swimming, half crawling, hunts through this vegetable network.

The river itself along this section exhibits a really grand sight. Its broad sheet of water, gravely moving on, is resplendent with reflected rays thrown upon its waters by a tropical sun; its surface is rippled by never ceasing breezes, regularly and alternately taking their turn

in blowing from opposite directions, now from the south, and then again from the north.

These cheering breezes are always hailed by the Atrato boatsman on account of their air purifying qualities, and for sweeping off the mosquitoes, while they at the same time are richly impregatned with the true balm of a thousand flowers.

The monotony in the sight of so broad a sheet of water is agreeably relieved by the continual descent of floating islands. There you see rafted together driftwood, living brush, and aquatic plants, such as Desmanthes lacustris, and Pontederea azurea, Sagittaria, Panicum, Polygonum, and other terrestrial plants, as Mikania, Dolichos, and a great many others of different orders and genera, which have come into involuntary contact with large vegetable convoys as they graze the banks. These are also enlivened by little herons, spearwings, kingfishers, crotaphagæ, swallows, and other members of the feathery tribe. Even young alligators occasionally make use of this kind of locomotion for their sports, and quietly descend the stream on board these floating rafts.

The scenery on the lower Atrato is of great beauty, combining in one the attractions of many other rivers. It almost equals the Mississippi in hydrostatic grandeur, and outdoes it far in scenery, for the son of the tropics everywhere shows an interesting back ground formed by the lofty mountain walls of the Darien Cordilleras, whilst the great father of rivers is rolling on through monotonous and unlimited flats of canebrakes and willows, and willows and canebrakes, with no distant view whatever. The Rio Grande de San Juan, as the Atrato was also called by the Spaniards, winds through an endless array of vegetable forms and floral treasures, both gigantic in size and wonderful in shape. As to the water itself, the Atrato water seemed to us as palatable as that of the Mississippi, Rio Bravo, or Colorado of the west, and also as pure in its ingredients, though it is as muddy and impregnated with sedimentary matter as the rivers referred to. About thirty miles below Sucio the last tributaries were seen entering the Atrato from the right. The upper one, with the name of "Leon," is marked by a low conical eminence, which rises abruptly from a swampy level just in the angle formed by the river's junction. Whether the origin of this little hillock is natural or artificial, we are not able to say. It is not improbable, however, that it is the result of the wash of both the intervening rivers. The hill is called el Tumarador—the meaning of which we could not learn. The word is a compound, and belongs to the language of the Chocós; the last syllable, *dor*, *do*, or *doh*, means river. It must be remembered that this word often appears in the hydrographical nomenclature of the country, as Truandó, Hingadór, Pabarandó, Chuparador, Curbarador, and others.

A short distance below, another little stream enters on the same side, bearing the name of "Tumaradorcito." It is likely that it is but a lower branch of the former.

3. *The Coast.*

a. The Delta.—From the Tumaradorcito down, the river resumes the character of a vast estuary. The identity of real tributaries becomes obliterated within a general lacustrine main. The Atrato, instead of receiving affluents, now commences to emit portions of its waters through several separate outlets. The tree growth becomes suddenly lowered, lacustric palms taking the lead, and finally forming the principal portion of a regular delta vegetation. The unavoidable water-loving Cecropia peltata, the mimosaceous dormidon, and some few others, here and there, remind the traveler still of a diversity, producing inter-tropical flora.

Few aquatics remain through this section, the same as were mentioned above, only the nearer the mouth of the river is approached the more types are thrown out—that is to say, equals increase against numbers. The effects of the salt water become more and more evident, and at last rhizophoræ and sea-loving cocoa palms appear, mingled up with fresh water forms.

Among the fern, one species is retained, which is closely related to another noticed on the margin of the Pacifican tide waters, and undoubtedly belongs to one and the same genus. It is quite singular that two species of one genus should represent the Alpha and Omega of fern growth along this line, each one descending to the edge of tide water on either ocean. Both species resemble each other very much in habit, only the leaves of one are acuminate, where its Atlantic equivalent has them obtuse.

The vernacular name of these eryptogams was given to me by one of the natives as "mata tigre," (tiger killer ;) the reason of which I could not learn, the plant being lacustric ; and for this reason, I suppose, wherever it grows, the Iaguar (tiger of the natives) never approaches, as cats generally do not like to take to the water.

The two palms appearing so conspicuously through the delta of the Atrato, are very probably the same which are mentioned by Humboldt during his visit to the Rio Sinú. (See his travels to the equinoctial regions of America, vol. 3, chap. xxx.) Neither of these palms form proper trunks, but both display great external similarity to each other. The one belongs to the sub-tribe, "Cocoineæ," and is probably identical with Elais or (Alfonsia) melanococca of Martius. The other is to be classed in the sub-order, "Lepidocaryeæ." The popular name of the latter is "Pángana," and of the former "Nolé, Antá, Corozo of the "Cartajeños," Corozo de Aceite, or Corozo del Sinú, according to Humboldt.

The fauna near and within the delta becomes simple in its features, and only animals of aquatic and aerial habits appear. For instance, of four monkeys observed above, only the red roaring monkey (mycetes seniculus) was heard and seen below. Also the miserable sloth, never needing bottom, occasionally appears in sight, hanging between the branches of low trees or shrubbery, where he finds his poor food, apparently not even rejecting the broad leaves of the poisonous *Caladium.* Among the grallatores and natatores, Ardeidæ, Pelicanidæ,

and Sternidæ become principals. Of Insessores, the white-beaked musophagous Icterinæ, of the genus Cassicus, swing their nests from the top branches of the mangroves, or within the never silent, unapproachable canebrakes which line the delta internally along the caños, or outside towards the gulf. As transient forms, numbers of psittacus macao are seen flying to and fro in small couples of from two to three individuals, following their daily sport all over the delta. Occasionally a snake is discovered in the tree branches over head, sleeping or lurking for prey. Numberless flocks of restless and noisy sturnidæ play about from one point to another to fulfill the duties nature has assigned them.

The hydrography of the river in approaching the gulf, besides the general delta features, exhibits also a certain peculiarity, already hinted at above. This is the general uniform depth of the river and its branches, together with the more or less vertically-cut and stable embankments of their respective channels. This feature, insignificant as it may appear at first sight, becomes important when received with regard to any necessary improvement in behalf of its outlets. Inquiring into the probable causes of the morphic condition of these channels, they must in all probability be charged to the hydrostatic condition, not only of the delta, but also of the adjacent gulf. The continued stowage within this narrow inlet (appropriately called by the old Spaniards "culata") keeps the whole main round the gulf, and for a considerable distance up the river, in a state of perpetual submersion, consequently the hydro-topographical configuration of the whole is produced under sub-aquatic pressure and shaped by undercurrents. However powerful, then, the Atrato may press down its vast body of water, its spreading tendencies become paralyzed as soon as it reaches the level of the delta. The soil forming the banks never becomes dry, not even during the season when rain ceases, because evaporation is entirely checked by the dense evergreen vegetation which covers the surface of the soil and the shallow swamps and lagoons. Thus the force of the river currents, on one hand, and the oscillatory motions of the tide waters, on the other hand, are made to quietly balance each other, following simply the law of gravitation. All coefficients, as drift, floods, freshets, or the waves of a broken surf from the outside, become neutralized at the level of the delta. This is not all, however. Our observations on the vegetable growth have shown the activity of the water conquering mangroves, and also that of the floating migratory aquatic plants, which, by means of entangling drift-wood, become rafted together in the shape of swimming islets. Now, whilst the mangroves, by their air-germinating seeds and untiring emission of aerial roots, extend their reach over the shallows far out into the gulf, and the vegetable rafts passing under their roots find a safe mooring, vegetable mold and other river sediment gather until a nucleus for a new conquest is ready. In this manner the delta, like some polypoid monster, would reach out its bristling tentaculæ, and, if it was not for other opposing agencies, the whole Gulf of Urabá would have been closed up long ago. There are fresh water streams entering the gulf, as well from the opposite side as also from its head, which all tend to keep the ingress of the Atrato

waters within certain limits. Their mutual opposition is finally also interfered with by the ocean currents entering and sweeping through the middle of the gulf almost through its entire length.

During the greater part of the season that branch of the equatorial current of the ocean which sweeps round the north side of the South American continent enters the mouth of this gulf, and is forced, by the presence of the fresh water inside, to recoil and seek its exit again. This probably gave rise to its Spanish epithet "la culata de Urabá."

In comparing the scenic appearance of the gulf and its surroundings with those about the terminus on the Pacific, both will be found of surpassing beauty and diversity of features. Both exhibit an equal share of boldly shaped mountain ranges, running in various distances through the densely wooded main of lowlands. Besides this general similarity, they, however, materially differ in one point, which is the almost entire absence of open beach on the borders of the gulf, whilst on the other side it occupies a prominent position along the peninsula of Paracuchichí. A continental appendix, like an oceanic break-water beach, always furnishes a scale for the wash of the tidal waves, the maximum and minimum rise of which may be readily recognized upon the face of the former. In the gulf of Urabá open beach is only an occasional occurrence, and seems to correspond strictly with the embarrassed tidal movements within its limits. Heavy tree-growth or dense delta vegetation descends to the water's edge all round, whilst the line of no vegetation along the peninsula of Paracuchichí rises nearly to eighteen feet above low water mark.

From a geological point of view the Gulf of Urabá, the Atrato delta, and, to a great measure, the whole basin of this mighty river, must be considered as a long continued estuary of extremely simple configuration. With a meridianal recipient axis of nearly four latitudinal degrees in extent, it runs parallel to and almost equi-distant from its lateral mountain borders, receiving the waters of numberless tributaries. The average bearing of the latter intercepts that of the former in most cases under a right angle, more or less modified by local interferences. Thus the potamographical configuration of the Atrato may be called as being from simple to three and more pinnate, to use a botanical technical expression, the main drainage serving as a hydrostatic rachis. In this mode we find the highest and the lowest portion of the country in structure strictly corresponding. The fresh water drainage from south to north being opposed by the pressure of oceanic currents, the quick filling up of that vast trend is easily conceived. If we carry this conclusion further, applying it also to the meeting of two antagonistic ocean streams, the first submarine foundation for the connection of two continents like that of North and Central America becomes but a natural result, which geologically does not date far back. The notes on the physiography of the Isthmus of Chocó may be closed here, leaving their more detailed references to be shown in separate tables and abridgments which will be appended as soon as the necessary investigations shall be worked out.

VIII.

APPENDIX A.

REMARKS ON THE GEOGNOSTIC STRUCTURE OF THE COUNTRY, WITH ACCOMPANYING DESCRIPTIVE TABLE OF GEOLOGICAL SPECIMENS.

BY ARTHUR SCHOTT.

In accompanying the subjoined table with the following remarks, it would be first deemed advisable to ask indulgence respecting the insufficiently of the material, a great deal more of which ought to have been collected whilst the party was on the ground. Those connected with the expedition know very well the difficulties under which the engineer party had to labor, in a latitude where the embarrassing growth of a tropical vegetation so seriously impedes almost all researches of natural history, and more especially those of geology.

Having given a general description of the physical features of the country, some brief hypothetical remarks on its geognostic structure may suffice. For further explanation, a geological profile and a descriptive table of specimens accompany this paper.*

Human knowledge in general, and the wants of the practical engineer, are especially interested in the solution of the principal questions involved in the subject under consideration.

All the stratified rocks on the isthmus, exhibiting strong marks of disturbance and even dislocation since they were originally deposited, clearly prove that the upheaval which brought this narrow neck of land above the level of the ocean must have taken place at a comparatively late era. This period was undoubtedly accompanied by the protrusion of certain metamorphosed shistose (?) rocks, the doubtful nature of which has induced us to mark them as as belonging to a trappean series. (See table of geological specimens, Nos. 8, 9, 17, 18, 19 and 20.)

If Darwin had good reason to believe that the granite of South America, now rising into central peaks 14,000 feet in elevation, must have been in a fluid state since the deposition of the tertiary group, we may also do so in pronouncing the formation of the Isthmus, now linking together South and Central America, as decidedly post-tertiary.

Baron Von Humboldt found at the foot of the Cordillera, near Cupica bay, on the Pacific, fossil wood mixed with rolled fragments of basalt and green stone. With this discovery, we may safely compare "Nagelfluhe," which now coats over the Atlantic slope of the oceanic divide at the Hingadór falls. (Compare sp., Nos. 7, 8, 9, 10, and 11.) Both fossils—those from the Hingadór as well as those from Cupica bay—are, in all probability, coeval, or nearly so. Mr. Trautwine, in

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*See table at close of the chapter.

his "Rough Notes" of a reconnoissance near the headwaters of the Atrato, and its equivalents on the Pacific side, expressly states that he did not find along his whole route any other than tertiary and a certain kind of "semi-rock." Mr. Trautwine's description of these rocks agrees pretty well with those occurring on the Truandó. (See spec., Nos. 4, 6, and 8.)

On the eastside of the Gulf of Urabá tertiary beds seem to continue. A piece of lignite coal was obtained at Turbo, which was said to have been taken from a layer a short distance back from that small port. The presence of the tertiary formation in that neighborhood would not be an extraordinary fact, for Humboldt too mentions similar strata at the mouth of the Rio Lenee, (Linee,) which is separated from the gulf of Urabá only by a few low, parallel-running hill ranges.

The same author speaks again of the tertiary formation as fully developed in the vicinity of Cartajena. It is zoölogically characterized by cardites and meandrites which abound in the strata situated on the east side of that town, between the hills upon which the old fortress of San Felipe and the convent of Santa Maria de la Popa are placed.

Pieces of these corals can be seen in use as building materials, and more especially for paving the streets of this once important port.

On the Cerro Pelado, a hill situated between San Felipe and La Popa, the tertiary formation of which seems also to be characterized by an excessive growth of a large cereus and a flat-fronted opuntia, we found the uppermost strata of the same formation, capped by various layers probably of post-tertiary drift. (See diagram.) The hypsometrical values of the hillsides near Cartajena are:

Convent of Maria de la Popa, about	600	feet.
Cerro de San Felipe, about	100	"
Cerro Pelado, (Bald hill,) about	120	"

The lower stratum, mentioned in connection with the Cerro Pelado, is so much weathered that the matrix, where the ferruginous nodules are imbedded in some places, has entirely disappeared, leaving but a mass of chaotically mixed up cryptomorphous nodules lying on the surface of the debris. Whether there exists any analogy between the tertiary formation found generally along the northern coast of South America and that of Brazil, we are not prepared to say; but we notice a singular analytic resemblance between the lignite coal of Turbo and some Brazilian specimens mentioned in R. C. Taylor's statistics on coal. The analysis reads as follows:

	Spec. 1.
Carbon	57.90
Volatile matter	40.50
Ashes	1.60
Specific gravity	1.289

	Spec. 2.
Carbon	38.10
Volatile matter	33.50
Ashes	28.40
Specific gravity	1.483

In examining the Turbo coal, we found, approximately—

Carbon	64.35
Volatile matter	32.00
Ashes	3.33

Loss, 0.32. (See sp. No. 14.)

Tertiary coal is also mentioned by R. C. Taylor as occurring north and south of the Isthmus of Chocó, both on the Pacific and the Atlantic side. Hot springs, salses, asphalt, and other bituminous fossils so frequently accompanying this geological group, seem to be quite common phenomena throughout Chocó and along the litoral regions of South America. How fully developed the tertiary formation of the Isthmus may be, we do not know, because we have not been able to identify any stratum similar to those near Cartajena; but we have to mention a striking congruity between some of the rocks on the Truando and certain tertiary river banks on the Bravo del Norte, about seventy-five miles in a straight line above its mouth. Here a similar high-colored, argillaceous marl forms beds of considerable thickness and extent, and exhibiting like those layers in Chocó a regular reticulated texture, by the copious interspersion of their leaves or sheets of silicated matter—with this difference only, that the silicious network pervading the Texian rock appears more or less chalcedonized—a feature not perceptible on the rocks of the Truandó.

The interposition of an older fossiliferous rock, (see sp. Nos. 15 and 16,) which was seen near the mouth of the Salado emerging between the tertiary beds, may indicate perhaps a general thinning out of the latter towards the vicinity of the trappean dam. The anticlinic and much disturbed position of all the sedimentary strata certainly helps to form the conclusion that the movements which caused their upheaval and partial rending do not date beyond the tertiary era, and that they were, in all probability, coeval with those disturbances which followed each other at short intervals not only along the great orographical spine of this continent, but also through the various provinces of the West Indian archipelago. Thus the trapporphyries which penetrated the immense cretacious table lands on both sides of the Braro del Norte, the Amygdaloids, and pseudo-columnar Trappdykes, overthrowing and superposing the carboniferous limestones of the upper portion of that river, and also the Trachytes and immense beds of black vesicular basalt or trap protruding and superimposing the tertiary and even quaternary flats and river banks of the Gila and Colorado of the West, may all have belonged to one great series of pluto-vulcanic movements. They finally caused the rising of these secondary and tertiary submarine lands which closely link together, to one great continent, long chains and clusters of islands, reefs, and submarine banks of the tertiary period. The connection of South and Central America must, then, have resulted at a period when the struggle of the antagonistic pelagic currents of the oceans was first interfered with. Before that time the westward flowing equatorial stream swept round the northern coast of South America and met at its north-

west angle, the great antarctic flows rushing towards the equator. The place where the force of these antagonistic currents met and necessarily paralyzed each other became the depository of the sediment which they carried. Within the angle of their encounter, where the waters remained quiet, a nucleus for future land was allowed to be collected on the bottom.

It is of little importance to know whether this deposition of future land took place upon a volcanic or plutonic dyke, which already may have formed a submarine connection between South and Central America, or whether the trappean rock of Chocó did not commence rising from the deep until after the tertiary formation was finished. A natural consequence of the appearance of the Isthmus above the level of the ocean was the ready shelter it afforded, on the Atlantic side, to a tropical fresh water drainage for the accumulation and creation of that vast inland estuary of the Atrato valley which now heads the Gulf of Urabá or Darien.

As to the orographical position the Isthmus of Chocó occupies, we consider its skeleton, that is, the underlying endogenous rocks, as a westernmost branch of the Cordillera Occidental of New Granada. Ranging NNW., it seems to lose elevation the further it runs out from the main trunk, the latter known under the name "Cordillera de Antioquia." Where the low Cordillera of Chocó reaches the lowest depression, it seems to meet equally low out runners from the Cordilleras de Darien, which maintain generally a westerly bearing. Within the angle formed by these orographical outliers on the Atlantic side is found that long-talked-of depression of country first pointed out by Humboldt as the place most fit for an interoceanic communication.

In regard to the probable degree of development, and the respective extent of each of the strata constituting the isthmus, we are not able to go beyond certain conjectures, especially so in respect to its western portion. So far as sedimentary strata are concerned, a proposed cutting through will meet with no serious obstacles, whilst at the same time this section will furnish choice material for building purposes. Calcareous rock may be expected almost to a certainty within the bounds of the tertiary and secondary formation, whilst the quaternary and alluvium in general will readily furnish plastic clay and clean driftsand. Heavy rocks for foundations and cyclopean work generally will be furnished by the trappean series. Material of this kind may be found of every degree of hardness and gravity with the limits of the Sierra de los Saltos; that is, from the foot to the head of the Truandó falls.

The geognostical distributions of this rock, however, deserve more consideration on account of the additional force which would be necessary in working through this mountain dam. Nevertheless, the shistose nature of this rock would assist greatly not only in blasting, but even in laboring with the pickax.

A pretty close estimate for the work of excavation through the trappean strata could easily be made by computation, taking in account the angles of dip and strike, and as a base line the distance measured through the formation at the Saltos. On the ocean divide, however, this rule could not be applied, because rock of this kind was only seen

on the western foot of the low Cordillera, and we have therefore nothing to base any theory upon. We do not know to what extent the trappean rock may be developed as a nucleus of this divide. If this rock, however, should have risen to any considerable height under the tertiary cover of this low mountain dam, traces of it ought to have appeared to the sight at or near the crossing of the little river Chupepe. This not being the case, we believe the trappean beds to be rather subordinate in the orographical structure of this western Cordillera.

IX.

APPENDIX B.

BOTANY—ALGÆ.

BY PROFESSOR W. H. HARVEY, WITH NOTES BY ARTHUR SCHOTT.

An introduction here of a list of Algæ, collected not immediately on either side of the line, may appear somewhat out of the way. If we consider, however, the short distance between the port of Cartajena and the Gulf of Urabá, and take also into account that great move of the waters, the equatorial stream, which enters through the lower part of the West Indian Archipelago, the Sea of the Antilles, and sweeps unceasingly in its course along the Atlantic coast of Central America, finally seeking its exit eastward again between the south point of Florida and the Island of Cuba, we can only view the whole region just defined as one oceanic province. Though difference of latitude may naturally create within the various regions of this great basin analogous differences in the development of their respective organic forms, such a tendency becomes essentially counterbalanced by that very gulf stream; the latter, by means of the distributing flow of its heated waters, neutralizes to a great measure all the multifarious climatic coefficients employed in this zone. Thus a certain uniformity pervades the whole body of animal and vegetable forms inhabiting this tropical province.

When we compare our little list of Algæ with the marine flora of the Florida Keys, or the shores of the Mexican gulf in general, a close relationship between the northern and southern portions of this oceanic basin is readily perceived.

Besides those homeless rovers of the gulf stream, the so-called Gulf-weed, (Sargassum vulgare and S. bacciferum, Ag.,) many forms which we know to exist on the Florida Keys, or on the coast of Tejas, or on any of the West Indian Islands, are also inhabitants of the salt waters near Cartajena, either on its open sea-side, or in the sheltered lagoons and ditches within the bay and along the fortifications of this old town.

Under the impression derived from such a general congruity in the growth of the vegetable forms throughout this region, the distance between Cartajena and the Gulf of Urabá becomes insignificant indeed. One limited collection of Algæ may therefore safely be taken as also representing the marine vegetation of the Gulf of Darien. There must certainly exist some local modifications, as is the case

everywhere, and it is especially on this point that I feel sorry in not being able to give more positive information.

Opportunities for botanical and other researches were afforded far below even our most modest expectations during a prolonged stay near the mouth of the Atrato. Thus the aquatic flora of the rarely visited Gulf of Urabá had to remain, as it was before, unexplored, as far as this branch of science is concerned. The few glances we were able to cast upon the shores of this bay met with so little success that we cannot help considering its algal growth very poorly developed.

Whether it is that the shores of this great estuary are so much embarrassed by extensive sandbars, which Professor Harvey very ingeniously considers as subaquatic deserts or barrens, or whether the presence of the fresh waters, which for the greater part of the year are stowed up within the gulf, present a more free development of Algæ, we are not prepared to state.

It is not less remarkable that the western terminus of the line is equally characterized by the entire absence of marine plants. Though an examination was then made of the sandy beach on the ocean side, for a distance of from two to three miles, still not a single Alga could be found.

Our hastily made observations proved naturally anything but satisfactory, which we regret the more as the finding out of the cause of this vegetable barrenness might have solved some other questions, in which the practical engineer is not less if not even more interested.

As to what our little collection merits towards systematic botany, Professor W. H. Harvey, of Trinity College, Dublin, who kindly examined it and prepared an authentic list, says: "Nos. 13, 16 and 18, (Rhytiphlæa or Sp. Alsidium Schottii, and Gracilaria multipartita,) appear to be new species, as far as I can judge. Some of the others as No. 2, (Gracilaria caudata, G. Ag., v. Sp. n?) are only provisionally determined, being species only known to me previously by description.

I. MELANOSPERMEÆ.

SARGASSUM VULGARE, Ag. Gulf stream in the sea of the Antilles.

SARGASSUM BACCIFERUM, Ag. With the preceding.

TURBINARIA VULGARIS, Ag. Tropical; sea-side at Cartajena.

*FUCUS NODOSUS, L. Extra-tropical; New York harbor.

*FUCUS VESICULOSUS, L. Extra-tropical; New York harbor.

*LAMINARIA, Sp? Imperfect specimen, extra-tropical; Sandy Hook, New York.

PADINA PAVONIA, LAMOUR. Tropical; Cartajena, sea-side, on rocks within tide marks.

ZONARIA LOBATA, Ag. Like the former.

DICTYOTA DICHOTOMA, Ag. Cartajena, on rocks thrown up by the surf.

*NOTE. The species marked with an asterisk were recognized at the time they were collected.

DICTYOTA BARTAYRESSIANA, affin. Tropical, with the preceding.
ECTOCARPUS OCTOSPORUS, n. sp., Harv. Tropical.

II. RHODOSPERMEÆ.

ALSIDIUM TRIANGULARE, J. Ag. Cartajena, sea-side, washed ashore.

ALSIDIUM SEAFORTHII, J. Ag. Ibidem.

ALSIDIUM SCHOTTII, n. sp. Harv. Tropical, with both the preceding.

ACANTHOPHORA ANTILLARUM, Mont. Tropical; sea-side at Cartajena.

CHONDRIA DASYPHYLLA, Ag. Extra-tropical.

RHYTIPHLÆA OBTUSILOBA, Ag. Cartajena, sea-side, probably thrown up from deeper water.

RHYTIPHLÆA, n. sp. Harv. Tropical; Cartajena, sea-side.

POLYSIPHONIA VARIEGATA, Ag. Extra-tropical, probably from Sandy Hook.

DASYA ELEGANS, Ag. Extra-tropical; habitat with the preceding.

LAURENCIA PANICULATA, J. Ag. Tropical; Cartajena, sea-side; washed ashore by the surf.

LAURENCIA GEMMIFERA, Harv. With the former.

LAURENCIA PAPILLOSA, Grev. On rocks within tide-marks, Cartajena.

GRACILARIA CERVICORNIS, J. Ag. Tropical; Cartajena.

GRACILARIA MULTIPARTITA, J. Ag. Extra-tropical; inhabiting both great oceans; also, tropical, Cartajena.

GRACILARIA CONFERVOIDES, Var. Tropical; Cartajena, on the sea-side.

GRACILARIA CAUDATA, n. sp.? Tropical, on the beach of Tierra Bomba next Cartajena.

GRACILARIA RANGIFERINA, Kuetz. With the former.

GRACILARIA DOMINGENSIS, Soud. Like the preceding.

GRACILARIA DURA? Harv. Tropical, with the habits of the three preceding species.

GELIDIUM CORNEUM, Lamour. Cosmopolitic, inhabiting both oceans and every latitude.

SOLIERA CHORDALIS, J. Ag. Extra-tropical; New York Harbor, Sandy Hook.

HYPNEA CORUNTA, J. Ag. Tropical; Cartajena, sea-side.

HYPNEA MUSCIFORMIS, Lamour, (form of.) Probably extra-tropical.

RHODYMENIA, (imperfect specimen,) near Rh. Palmetta. Grev. Tropical; Cartajena.

RHABDONIA TENERA, J. Ag. Tropical; Cartajena.

PHYLLOPHORA MEMBRANIFOLIA, J. Ag. Extra-tropical.

HALIMENIA FLORESIA, Ag. Tropical; thrown up by the surf at Cartajena.

SPYRIDIA FILAMENTOSA, Harv. Widely distributed.

CENTROCERAS CLAVULATUM, Ag. Tropical.

III. CHLOROSPERMEÆ.

CAULERPA PLUMARIS, Ag. Tropical; lagoons and ditches about the fortifications of Cartajena.

CAULERPA CLAVIFERA, Ag. With the former.

HALIMEDA TUNA, Lamour. With the preceding.

CODIUM TOMENTOSUM, Stack. Cosmopolitic, occurring in every zone, from the equator to the poles. Washed ashore on the Sierra Bomba, near Cartajena.

CLADOPHORA LÆTEVIRENS, Dillw. Widely distributed.

Very graceful forms of this plant were collected at Cartajena.

X.

APPENDIX C.

BOTANY.—FILICES AND LYCOPODIACEÆ.

BY DANIEL C. EATON, ESQ., WITH NOTES BY ARTHUR SCHOTT.

The Filices, together with the Lycopodiaceæ, though not possessing the grandeur of the Palms, or the singular grace of mimosaceous trees, or the gorgeous development of the foliaceous organs of the Musaceæ, compare nevertheless favorably to these stately forms of tropical vegetation. They are also leading forms, especially and pre-eminently so through sparingly ventilated localities, when a stagnant, moist atmosphere is allowed to remain undisturbed and scarcely touched by solar light. There they luxuriate in close company with plants of other orders, but very similar in habit, as for instance: Orchidaceæ, Aroideæ, Bromeliaceæ, Pandanaceæ, Musaceæ, and others. Like other Cryptogams, they are deprived of the charms of blossoms; but, as if this very deficiency had effected an increased morphic power for the shaping and formation of their fronds and leaves, the variety of these latter organs becomes with them as endless as it is astonishing.

Not less characteristic is the tenacity by which ferns are able to conform themselves to the most diverse places of habitat. The column of their vertical distribution reaches from the tidal wave of the ocean up to the most elevated regions of Alpine barrenness. We see them again flourishing through the sinister shades of swamps, or shrunk up for many months in arid deserts, where they only revive for a short space of time when touched by some occasional rain fall. According to the nature of their habitat, the polymorphism of their stems, root-stocks, as well as their foliceous organs, varies through the most extreme forms known to botanists.

There is about ferns also a kind of *historical charm*—if the expression is admissible—which makes them particularly attractive; for if we go back in the history of vegetable developments, we find through the revelations of geology, that, during the carboniferous era, Filices, together with other orders, now more or less extinct, have been the leading forms.

At that time, at least, numerical predominance seems to have been theirs; and it would also appear that there the climatic condition of our globe had been much more favorable towards filicial and kindred growth than is the case at present, where the occurrence of these cryptogams is only more or less local.

Thus the subsylvatic flora of the tropical isthmus forms a vegetable substratum composed chiefly of lower forms with fossil affinities as to

cause and result of their growth. This stratum is deeply overlaid by strata of higher organized plants, but with a pedigree of later date.

Remarks with reference to the species of collection are embraced in the subjoined enumeration.

For the analytic and descriptive arrangement of the latter, we are greatly indebted to the liberal kindness of Daniel C. Eaton, Esq., of New Haven, Connecticut.

FILICES.

ELAPHOGLOSSUM RUBIGINOSUM, *J. Smith.* Acrostichum rubiginosum, *Fee; 2m. Mem. p. 47, t. 5.*

This species was seen only within a limited locality near the foot of the Truandó falls, where it was taken from the trunk of trees.

ELAPHOGLOSSUM APODUM, *Kaulf.* Acrostichum apodum, *Kaulf; fide Hook and Grev; Sc. Filic. t. 99.*

More common than the former species. It usually grows far above reach, in the top of high trees, associated with a certain flat fronded Cereus, and various species of Bromeliaceæ. Shores of Atrato and Truandó.

ACROSTICHUM AUREUM, *L.*

Salt marshes and shores within tidal reach on each side of the Isthmus are the home of this common fern. The vernacular name of the plant is matatigre, (tiger killer.) Some of the natives maintain that the plant is a deadly poison to the dreaded tiger, (jaguar.) We know not how much this statement is to be credited; but it is most certain that wherever this Acrostichum grows, all the larger members of the feline tribe are naturally excluded by the lack of firm soil to walk upon, or by the absence of larger trees, upon which they could follow their sport. There is another point of interest connected with this species, of which two differing forms were collected, each one belonging to a different region.

The one from the Atlantic shore has sessile, obtuse, ligulate leaves, whilst those of the Pacific form are acuminate ligulate, with short petioles. Still there is, since Linnæus, but one established species, the description of which agrees well with our Atlantic form. With the scant material on hand we would not, however, feel justified in making the Pacifican plant more than a mere variety.

It is, however, a singular incident that two varying forms of one species of fern shall represent the first and the last of filicial growth upon the line of transit on the isthmus, each form respectively on each side touching the zero point of terrestial vegetation.

BLECHNUM OCCIDENTALE, *L.*

This apparently gregarious plant belongs to the center part of the line along the Nercua and upper Truandó. It is a water-loving plant, and frequently associated with Meniscium reticulatum, Polypodium

macrourum, and a few others of the class. It adorns the broken banks of both these streams.

VITTARIA STIPITATA, *Kunz, Analicta, p.* 28, *t.* 18.

A beautiful pendulous epiphyte, waving in graceful clusters from the limbs of overhanging trees along the rivers Atrato and Truandó.

TÆNITIS ANGUSTIFOLIA, *Spring; Metten; Fil. Lips. p.* 27. *Pteropsis angustifolia, Desv.*

Dendricolous; on the Truandó.

TAENITIS FURCATA, *Willd. Metten;* 1. *C. Pteris furcata, L.*

On trees with the former, and frequently associated with various orchidaceous species, together with other epiphytic forms.

LINDSÆA TRAPEZIFORMIS, *Dryander.*

This beautiful plant, like the other members of the genus, is confined to the more elevated sections of the country. Being terricolous, it is excluded from the floating marshes of the lower Truandó and Atrato.

LINDSÆA (DICTYOXIPHIUM) PANAMENSIS, *Metten, Fil. Hort. Lips. p.* 105, *Hook, Fil. Exal. t.* 54, *Dictyoxiphium Panamense, Hook. gen. Fil. t.* 62.

LINDSÆA (DICTYOXIPHIUM) MICHLERIANA, *sp. nov.* Erecta, glabra stipite elongato gracili parce paleaceo; fronde, membranacea ampla ovat-lanceolata, basi subcordata, vix decurrente, sursum sinuato-lobata; apice sinuata, laciniis latis oblongis venulis, anastomosantibus; areolis appendiculatis, costalibus elongatis; soris intramarginalibus interuptis oblongis vel linearibus.

With the preceding form, but apparently rare. Truandó Falls.

The affinities of this fern are obviously with *Lindsœa Panamensis*, but it differs in several marked respects. The stipe is several inches long, slender and sparingly chaffy. The fronds measure from twelve to fifteen inches in length, and from six to eight inches in width at the base. They are pinnate at the base, deeply lobed in the middle, the lobes becoming shallower towards the top, so that the upper third of the frond is broadly linear with a sinuate margin. The venation is very like that of *L. Panamensis*, except that it is looser and rendered more evident by the somewhat thinner texture of the frond. A fragment of fruit shows the sori scattered along the margins but with the indusium opening outward as in other *Lindsœas.* The root stock I have not seen.

I take great pleasure in dedicating this well marked species to Lieutenant N. Michler, United States Army, in charge of the topographical survey of the route for a ship canal, to whose attention and liberality we are in great part indebted for the objects of natural history collected during the survey.

ADIANTUM MACROPHYLLUM, *Swrtz.*

This species is like all others of the genus terricolous, and was found in corresponding localities with them along the upper Truandó and Nercua.

ADIANTUM SEEMANNII, *Hook. Sp. Fil.* 2, *p.* 5.

Upper Nercua and dividing ridge.

ADIANTUM LUCIDUM, *Swrtz.*

Summit of the dividing ridge between Aspinwall and Panama.

ADIANTUM KAULFUSSII, *Kunze. Hook. l. c. p.* 7.

Habitat, Turbo, east side of Bay of Urabá.

ADIANTUM OBLIQUUM, *Willd. Hook, l. c.*

Turbo, east side of Bay of Urabá.

ADIANTUM VILLOSUM, *L.*

On the Truandó.

ADIANTUM PRIONOPHYLLUM, *H. B. K.*

Truandó. The specimens are rather small, and the fruit extends quite around the ends of the pinnules.

ADIANTUM HIRTUM KLOTZSCH, *Hook, l. c. p.* 20, *t.* 82.

Dividing ridge.

PTERIS QUADRIAURITA, *Retz.*, *Hook, l. c. p.* 179.

This plant appears to be not common; it was collected in the more dry section of the dividing ridge.

PTERIS (LITOBROCHIA) KUNZEANA, *Agarth.*

This species, with the following of the genus, seems to be very common along the Lower Truandó, especially in the "Palizadas." They make themselves quite conspicuous by bold growth, frequently attaining a height of from four to six feet. Though usually terricolous, they often locate themselves on old decaying trees which time has left standing up. Thus they appear associated with other climbers.

PTERIS (LITOBROCHIA) PODOPHYLLA, *Swartz, Hook, l. c. p.* 227?

The ticket with the specimens says: "The stipes are often an inch in diameter and armed with short and conical strong spines." Frond from four to six feet high, ample, tripartite; branches pinnate; pennules oblong-linear; elongated, deeply pinnatified; segments oblong; falcate, serrate at the apex, sinuses rounded; basal veins forming a *single arc* parallel to the costa.

ASPLENIUM SERRATUM, *L., Hook. Fel. Exot. t.* 70.

This climber usually occupies the lower part of forest trees in the marshy regions of the Truandó and Atrato.

ASPLENIUM ABSCISSUM, *Willd. Metten. Aspl. p.* 101.

This species, also a tree inhabitant, seems to have a wider range than the former, as it was collected in various localities, from the marshes up to the table-land and the dividing ridge.

ASPLENIUM SALICIFOLIUM, *L.*

This is one of the bolder forms of the genus chiefly found in the lowlands along the Truandó. It is terricolous.

ASPLENIUM VIRENS, *Presl. Rel. Hœnk.* 1, *p.* 41, *t.* 6?

Habitat, low grounds on the Truandó.

ASPLENIUM ALATUM, *H. B. K. Hook. and grev. Ic. Fil. t.* 137.

Common on the upper Truandó and Nercua. It is exclusively a climber, adorning the lower part of trees with graceful festoons. The season of January and February, however, seems to have not been the proper time for collecting the fertile fronds of this fern, as we rarely met with them.

ASPLENIUM AURITUM, *Swrtz. Metten; l. c. p.* 103.

A common species, occurring almost along the whole line.

ASPLENIUM,—*sp?*

Fragments of a fern with large decomposed fronds. Upper Nercua, in marshy thickets, on the ground, and associated with Dicksonia adiantoides, and Phytelephas macrocarpa. The species much resembles Asplenium Filix fœmina, R. Br.

DIPLAZIUM SHEPERDI, *Presl. Fent. p.* 114. *Asplenium Sheperdi, Spreng; Metten; l. c. p.* 164.

This species was first seen on the Truandó, some little distance above the mouth of the Nercua. It forms a small arbuscle, with a stem from six to eighteen inches high, and nearly one inch in diameter.

DIPLAZIUM COSTALI, *Presl. l. c.*

Of this species only one individual was seen on the Pacific side of the dividing ridge.

DIPLAZIUM GRANDIFOLIUM, *Swrtz. Asplenium grandifolium. Metten;* 1 *c. p.* 178.

Fragments of other Diplazia were collected with those enumerated; their want of perfection, however, forbids final determination.

With regard to the Diplazia of the collection, we made the general remark that they do not seem to descend much into the marshy portion of the route. They all seem to be strictly terricolous.

GYMNOGRAMME CALOMELANOS, *Kaulf. Enumerat. p.* 76.

A common form all along the line of our travel, but appearing more or less sporadically.

GYMNOGRAMME TARTAREA, *Deso. Metten; Fil. Lips., p.* 41.

Terricolous, like the preceding, but, as it appeared, less common. A large number of specimens were found upon a land slide near the Truandó Falls, the barren surface of which they occupied almost exclusively.

MENISCIUM RETICULATUM, *Swrtz.*

An inhabitant of low, boggy places about the Truandó Falls, and also near Turbo, on the east side of the Gulf of Urabá, where it occurred with its congener.

MENISCIUM PALUSTRE, *Radd. Filic. Bras. p.* 9, *t.* 20.

MENISCIUM ANGUSTIFOLIUM, *Willd.* 5, *p.* 134.

Terricolous, like the two preceding forms, this plant is decidedly of gregarious habits, forming extensive patches on the banks of the Truandó and Nercua. In its mode of growth it approaches Blechnum Occidentale, and Aspidium macrourum.

ANTROPHYUM CAYENNENSE, *Kaulf. Kunz. Anal. p.* 30, *t.* 19.

ANTROPHYUM CITRIFOLIUM, *Fee. Antroph p.* 51. Anetium Citrifolium, Splitgerber. Moore Ind. p. 72.

This fern, like the preceding, is truly dendricolous. Both seem to have a similar range within the low lands along the Truandó.

POLYPODIUM TRICHOMANOIDES, *Swartz, Metten. Polypod. p.* 40.

This neat little tree inhabitant, which, under the disguise of some Leskea or Jungermannia so easily escapes being noticed, seems to have its range within the low lands of the Truandó.

POLYPODIUM ELASTICHUM, *Bory. Metten., t. c. p.* 47.

Also dendricolous, and in neatness and diminutive proportions a match to the preceding, seems to represent the former on the Pacific slope of the dividing ridge.

POLYPODIUM, (Goniophlebium pectinatum.) *J. Smith in Bot. Voy. Herald. p.* 220.

This beautiful fern adds most conspicuously to the scenery in the marshes on the Atrato and Truandó. Truly arboreal in habit, it waves in long pendulous festoons from overhanging trees, lowering its slender fronds frequently to the very edge of the water below. The fronds, often attaining the length of from 8 to 10 feet, appear like green ribbons playfully suspended by the old foresters to float upon the rippled surface beneath.

POLYPODIUM (GONIOPHLEBIUM) LÆTUM, *Raddi; Fil. Bras. p.* 19, *t.* 28.

A large form resembling somewhat the former, but inhabiting the ground.

POLYPODIUM (CAMPYLONEURUM) REPENS, *Swartz; Metten; Fil. Lips. p.* 34, *t.* 24.

One of the most conspicuous forms of the Polypodia collected. On account of the shape of its large undivided frond it received the vernacular but not very complimentary name "Rabo de babilla, or cola hediondo."—This refers to the long yellow tail of a certain bird "Icterus cristatus" ? also an inhabitant of these regions, and odious to the people there for its thievish proclivities, which it exercises in the cornfields and plantain patches of the country. The same name, however, is also given to quite different plants, as, for instance, to a certain flat-fronded dendricolous Cereus, which somewhat resembles our fern.

POLYPODIUM (CAMPYLONEURUM) FASCIALE, *Willd.*

The preceding remarks apply also to this and the following species. They are all dendricolous, and of common occurrence along the Truandó, Nercua, and Atrato.

POLYPODIUM (CAMPYLONEURUM) TÆNIOSUM, *Willd. Metten.* 1. *c.*

POLYPODIUM (PLEOPELTIS) PERCUSSUM, *Cav.*

A true climber, ascending frequently to the very treetops 100 to 120 feet high; it is common through the low land of the Truandó.

POLYPODIUM (PHYMATODES) CRASSIFOLIUM, *L. Metten;* 1, *c. p.* 109. On the Atrato.

Inhabiting trees only, it was mostly found upon Crescentia Cujete, (Calabash tree.) This plant is also one of the various rabos de babilla of the natives.

PHEGOPTERIS SEEMANNII. *J. Smith in Bot. Voy. Herald, p,* 228, *t.* 49.

Occurs through the more elevated regions along the upper Truandó and Nercua. It was found associated with Diplazium Sheperdi, to which it bears some resemblance by its arbuscular growth.

ASPIDIUM (CYCLOPELTIS) SEMICORDATUM, *Swartz; Metten; Phegopt. and Aspid. p.* 36.

This dendricolous fern contributes to the scenery of the low lands about Bas Atrato and the Lower Truandó, in a similar manner as does Polypodium lætum.

ASPIDIUM SPENGELII, *Kaulf. in Enumeratio Filicum, p.* 239; described also by *Mettenius*, in his account of *Aspidium, p.* 81.

ASPIDIUM (LASTRÆA) MACROURUM, *Kaulf, Enum., p.* 239.

This species is of a somewhat gregarious habit, forms large patches along the broken banks of the rivers Truandó and Nercua, where it appears frequently alternating with Blechnum Occidentale.

ASPIDIUM (LASTRÆA) MEXICANUM, *Presl. l. c.* 1, *p.* 38.

This is one of the most beautiful forms of its genus, bearing rich decompound fronds of a livid green. Its habitat is upon low ground along the Truandó.

ASPIDIUM (NEPHRODIUM) CUNNINGIANUM, *Kunze. Fil. t.* 9; *J. Smith in Bot. Voy. Herald, p.* 237, *t.* 50.

A neat form of its tribe, bearing an undivided frond on a slender petiole. It was met on the Nercua, forming few sporadic patches, associated with Adiantum macrophyllum, Aspidium molle, and Aspidium macrourum.

ASPIDIUM (NEPHRODIUM) MOLLE, *Swartz.*

With the former on the Nercua, and also in a few places on the dividing ridge.

ASPIDIUM LATIFOLIUM, *Presl. Rel. Haenke,* 1, *p.* 30; *Metten; Phegopt; & Aspid. p.* 118.

Apparently rare, as it was seen only in one place on the eastern slope of the dividing ridge.

ASPIDIUM MACROPHYLLUM, *Swartz; Metten.* 1, *c. p.* 122.

This fern frequently occurs along the Nercua, within reach of overflows.

ASPIDIUM TRIFOLIATUM, *Swartz.*

A terricolous fern, inhabiting low marshy places along the Atrato and Truandó.

ASPIDIUM DRACONOPTERUM, (*nov. sp.*)

Elatum, amplum; stipite elongato paleaceo; fronde ovato e basi cordata glabra pinnatifida, laciniis 7–9 suboppositis ovato-oblongis

integris vel leviter sinuatis acuminatis infimis brevioribus terminati duplo vel triplo magiore, ala lata confluentibus nervis secundariis costæformibus, venulis reticulatis, maculis primariis utrinque ad costam 6–10 seriatis; soris plerumque apici venularum insidentibus inter costes secundarias 6–8 seriatis, indusiis ignotis.

Habitat, Turbo, east side of the Gulf of Urabá. Terricolous.

Stipe a foot or more high, brown chaffy, with narrow, crisped, brownish scales. Frond a foot and a half or two feet long, two thirds as wide; dark dull green above, paler beneath, smooth both sides. Segments of the frond three or four pairs connected by a wing six to twelve lines wide along the rachis; the lower segments distant obliquely ovate, five to six inches long; the middle ones, seven to nine inches long and four inches broad; all of them a little wavy in the margin, and with a narrow acute apex. The veins are reticulated as in *A. macrophyllum*, but the sori, from which the indusia have fallen off through age, are very numerous, there being often as many as twenty or thirty in a primary areole, between the secondary nerves and the transansi arcs. The species may be compared with *A. alatum*, Wallich, but lacks the winged stipe conspicuous in that species.

DICKSONIA ADIANTOIDES, *H. B. K. Willd, V. p.* 488.

Fragments of a fern, that may be this species, were collected on the dividing ridge. Apparently rare—only met with once.

DICKSONIA RUBIGINOSA, *Kaulf. Enum. p.* 226.

Habitat, Lowlands along the Truandó; terricolous, not common.

DAVALLIA INÆQUALIS, *Kunze, var. intermedia Hook, Sp. Fil.* 1., *p.* 180.

On the table lands of the Nercua—apparently rare.

HYMENOPHYLLUM REMOTUM, *Van der Bosch, Synopsis Hymenophyllarum p.* 73. *H. Ciliatum, Hook & Grev, Ic. Fil. t.* 35.

The only species of this interesting genus was found within the lowlands as well as upon the table lands of the Isthmus. It always appeared closely associated with Lycopodiaceæ, Musci, Jungermanniaceæ, and other cryptogams.

TRICHOMANES ELEGANS, *Rudge; Hook; Sp. Fil.* 1, *p.* 115. *Feea Borge, Van der Bosch,* 1. *c. p.* 7.

TRICHOMANES MEMBRANACEUM, *L. Hook, l. c. p.* 115.

TRICHOMANES FLORIBUNDUM, *H. B. K.? Hook & Grev, Ic. Fil. t.* 9.

Whether these specimens are *Neuromanes Hedwigii*, or *N. Kaulfussii* of Van der Bosch, (1. c. p. 8,) is unknown to me.

The three forms of Trichomanes seem to belong to the western section of the line which enjoys a better ventilated climate than the low-

lands of the Truandó and Bas-Atrato. *T. elegans* has its eastern limits about the Truando falls, whilst *T. membranaceum* and *T. floribundum* have not been found further east than the dividing ridge.

CYATHEA, sp?

At the tree crossing of the Hingadór; apparently a large form of *Cyathea Schanshin, Martius. Ic. Crypt. Bras. p.* 77, *t.* 54.

A pinna is two feet long and seven inches wide. Caudex fifteen or sixteen feet high, with a diameter of five inches. This is the only tree fern seen along the line of travel. It seems to be rare and confined only to a small range on the east slope of the dividing ridge at the head of the Hingadór falls, where I observed some six or seven individuals scattered about.

LYGODIUM VOLUBILE, *var. S. Smith in Bot. Voy. Herald, p.* 242. Truandó falls.

The lowest pair of pinnæ are six to eight lobed, the upper ones three lobed; the lobes four to six inches long, half an inch wide, glabrous, and finely serrated. It can hardly be a variety of *L. volubile Swartz*, and is probably an undescribed species.

This fern belongs also to the western portion of the line, and has its eastern limit like other terricolous members of the class about the Truandó falls.

SCHIZÆA ELEGANS, *Swartz, Syn., p.* 151.

Exclusively on the Pacific slope of the dividing ridge. Not rare where it occurs.

DANÆA, sp?

Sterile specimens of some *Danæa* were collected along the Truandó. The fern under this head, though terricolous, was also found occasionally upon the lower part of decaying tree trunks. In this respect it has some affinity to one or two of the Litobrochia, mentioned above among the Pteridæ.

LYCOPODIACEÆ.

SELAGINELLA JUNGERMANNIOIDES, *Spring. Monogr. I, p.* 117. Truandó falls.

The specimens have a paler hue than those I have seen from Brazil, and are less branched, but do not appear to be otherwise essentially different.

SELAGINELLA LÆVIGATA, *Spring*, 1, *c. p.* 137. Las Palizadas, Truandó.

There is another plant in the collection, which may be considered a small form of this species.

SELAGINELLA FILICINA. *Spring. l. c. p.* 189. Truandó falls.

A very handsome plant, not unlike a fern in outline and general appearance, and with a bright red stem.

SELAGINELLA FLABELLATA. *Spring.* 1, *c. p.* 174? Truandó.

Small sterile specimens of what may be this species.

SELAGINELLA PÖPPIGEANA. *Spring. l. c. p.* 217. *Hook. Fil. Exot. t.* 56. Truandó.

One of the species having an articulated stem, and accordingly the specimens are broken into small pieces.

SELAGINELLA GALEOTTII. *Spring. l. c. p.* 220.

This has also an articulated stem. The leaves are entire, and not at all ciliated at the base.

Nos. 8 and 11 are unrecognized species of Selaginella; the former a very slender trailing species.

Note of the collector.—Some of the natives informed us that this species is considered an efficient styptic in the people's materia medica. We had no opportunity, however, to test this statement. The vernacular name of the plant is Sanguinaria. Whether the bright red stem of this graceful plant or really its medicinal properties caused this significant epithet is yet an open question. This is the only instance we know of, that any cryptogam of this order is used to some purpose by the natives in the country. In the tropics, where nature poured out her boundless riches, both animal and vegetable, it appears only natural if plants of lower organization have gained less reputation, as is the case in other regions, especially in higher latitudes, where even Lichens, Algæ, Ferns and other cryptogams have received more consideration.

On the northern limits of the subtropics in the State of Coahuila (Mexico) a certain fern takes the place of the tropical styptic of Selaginella flabellata, Spring. There Polypodium vulgare L. under the popular name Polandrillo, is among the Coahuilians used for women in confinement to prevent too great a loss of blood.

A. SCHOTT.

XI.

APPENDIX D.

BOTANY—PHANEROGAMÆ.

Having received no account in return on our collection of this class of plants, we propose to present here but a condensed enumeration of field-notes, which have reference to those genera and species which we have been able, by means of our transient observations, to identify approximately on the spot.

In the appendices full accounts on Algæ and Filices were given, and, as only very few other cryptogams have been collected, we omit mentioning them, and begin here with—

GRAMINACEÆ.

Guadua latifolia? Found on the Turbo river in March in full blossom, which, we are told, is a very rare occurrence. The culms of this gigantic grass form a very important building article for the inhabitants of the country. Single joints of one foot or fifteen inches diameter are employed as tubes or vessels for carrying fluids. The Spanish name in Chocó is "caña brava."

Another species, perhaps only variety, (G. angustifolia) may probably be found in corresponding localities with the former.

Panicum depauperatum? Muhl.
Panicum, sp?
P. Latifolium, L.?
P. Glaucescens.
It is remarkable for its gregarious habits, by which this grass forms patches of great extent in the meanderings of the rivers Atrato and Truandó.
Eragrostis reptans, Nees?
Diplachne fascicularis, Beauv. Torr.?
Setaria viridis, Beauv.
Setaria, sp?
Eleusine virgata.
Uniola, sp. (Playa of Paracuchichí.)
Cenchrus tribuloides, L.

CYPERACEÆ.

Few members of this family were collected; among them one specimen of Scirpus, one of Eleocharis. The latter is remarkable for its

close affinities to E. equisetoides, of Torrey. Our tropical form is only of much larger dimensions, often reaching a height of more than three feet. Of Cyperus two forms were collected. The few forms belonging to this family cannot by any means be regarded as a fair representation of what it cannot fail to be in a country of so thoroughly aquatic features.

ARACEÆ.

In the scenery of the lower sections of the isthmus this order forms a feature almost as striking as those of the Palmaceæ or Musaceæ. All the forms observed were arborescents or climbers. On account of the very difficult task to preserve aroid plants, especially under a moist tropical atmosphere, but very few specimens could be saved for the collection. The most prominent form of its numerical distribution is a species of Calladium (C. arborescens.?) It frequently covers, by an exclusive growth, very large tracts of the overflow along the rivers Atrato and Truandó. Another form, a climber, which may be a species of Philodendron of Schott, is remarkable for its being a prominent member of the undergrowth adorning, in company with certain ferns and various forms of Pothos, the dark colored, almost branchless trunks of trees in those subsylvatic regions of everlasting shade. A third form, terrestrial, and of arborescent growth, occupies similar localities with the former. The plant obtrudes itself to every general traveler by an extremely evil odor which it exhales when any part of it is wounded. This bad scent so strikingly resembles that of a Viverra or Mephitis, that the plant may properly be called "the vegetable skunk." The natives call it "hoja de sajino," (herb of the Peccary,) probably on account of its habitat, which is also the favorite resort of this pachyderm. To botanists the plant is known as a species of Dieffenbachia. (Schott.)

PANDANACEÆ.

Of this palm-like order one representative was observed, in the shape of a Carludovica palmata, known under the more general vernacular name of Jipijapa. The Chocó Indians call it "Matampa." We were informed that the former is the name of a province in the republic of Ecuador, whence the so-called Panama hats first entered commerce at large, and that, in consequence of this shrub furnishing the raw material for this celebrated fabric, received the same name, or, what appears more probable, that the Indo-Spanish province of the South American republic took the name of the plant. Señor Casanova, regidor of Turbó, to whose kind attentions we are much obliged for much information in regard to plants and animals of the country, states that only the top portion of the unexpanded center leaf is used for the fabric mentioned. For this purpose the laminæ of the fan-shaped frond are dried and afterwards dipped in hot or boiling water, in order to prepare it for bleaching. The same gentleman told us that a much more durable material for the same purpose is gained in

the province of Chocó from analogous parts of the leaves of some Pijiguai palm, which is probably a Martinezia.

PALMACEÆ.

Of this majestic order of plants at least from ten to twelve different species have been noticed. Near Turbó, a small village on the east side of the Gulf of Urabá, a cabbage palm abounds, which tree bears the name of Palmiche. This is very probably a species of Areca.

The "Bariga" of the natives is the large terminal bud of the tree which furnishes the much-cherished palm cabbage. Various forms belonging to the same genus were noticed along the rivers Atrato, Truandó, and Nercua. They are all remarkable for their exceedingly slender growth and slender leaves. One of them of the most graceful form bears the vernacular name of "Murapó," another "Escoba," on account of their broom-shaped leaflets. A third form is called "Raiza," because its rootstock rises from three to four feet above ground. From there it sends down a densely packed fascicle of radiating roots, forming a solid pedestal, upon which the slender shaft of the palm is balanced. The name "Raiza," however, does not apply to this species exclusively, but comprises several forms of the same genus, and even others less closely allied, all of which have their roots similarly arranged. A fourth form, probably of the genus Areca, in its outside appearance somewhat resembling the Palmiche, was observed on the Nercua. Various names are given to it, as "Cajon," (box,) "Puerto Rico," and "Palma amarga," (bitter palm.) A fan-leaved palm, which is also one of the Raizas, was observed on the Nercua. No traces of inflorescence or fructification were on it at the time, thus nothing could be done towards closer identification. Its vernacular name is "Quitasol," which means "parasol."

On the banks of the lower Atrato, and within the tidal reach of the delta, two stemless palms form immense thickets. One, according to its scaly carpels, seems to belong to the family of Lepidocaryeæ of Martius. It sends up fronds from 25 to 30 feet high. The natives call this palm Pángana—a word unintelligible to us, if it is not the negro Spanish for Pantano. Pantano, in Spanish, means bog, mire, or swamp, which seems to be the exclusive habitat of this palm. The other form, with less erect fronds, but of like size, is the Antá of the natives of Cartajena. It flourishes in the same localities as the former. The leaflets of the pinnate frond are inserted under a larger angle to the aculeate rhachis. The inflorescence of this stemless palm is entirely sessile in the axils of the older fronds where it forms a flat, much expanded spadix, containing innumerable almondlike kernels which, according to our native laborers, furnish the Manteca de Coroso, (palm oil.) This is in general use, and a staple article in the market of Cartajena. Another native name of this tree is "Noli." Whether this palm can justly be referred to Humboldt's Corozo de Sinu, which is an Elais, or Alfonsia, we are not prepared to answer. Señor José Sanchez, of Cartajena, son of the late United States consul at that place, among other valuable information, mentioned also a native mode for making more fruitful this oil-furnishing palm. To this end

they set the rough outside of the tree on fire, which is permitted to enter to a certain depth of the trunk, when it is extinguished again, having thus secured at least a three-fold yield for the season.

The family of Cocoeæ, both the spiny and the unarmed, is largely represented along our line of survey. Of Bactris, three different forms came to our notice, but we are not certain if they belong really to three distinct species. One form appears sporadically on the shores of the Atrato and Truandó, where it occasionally forms dense patches, called by the natives Corozales, for this genus of palms also bears the vernacular name Corozo. The tree, though small, attracts notice on account of its very slender, wiry stem, which is well armed with hard, bony spines, from two to three inches in length. The fruit, resembling somewhat that of a grapevine, consists of a number of bony kernels, covered by a thick fleshy skin, which contains an acid juice agreeable to the taste. On that account it is frequently brought to market in Cartajena. The inflorescence is a loose raceme. The size of the fruit is about that of the berry of the grapevine.

The natives distinguish two more forms belonging to this genus; one with berries of the same size as the former, about four or five lines diameter, but with a perfectly dry pericarp of a yellow color; and another with berries of walnut size, which are surrounded by a much more pulpy pericarp. In other parts of New Granada these trees are called Mararai. General Mosquera, in his physiographical essay on this country, mentions three species of Bactris, as B. gachipæ, B. major, and B. minor; but we do not feel justified to refer the three forms mentioned to these specific names.

Another trio of armed Cocoeæ is formed by the genus Martinezia. The forms to which we have reference are, in every respect, much more conspicuous than the former. Being also of more importance to man, they deserve special notice.

The Chontaduro (Martinezia Ciliata?) is one of the most beautiful palms on the Isthmus, and the usefulness of its wood and fruits seems to equal its external appearance. The trunk of this palm is densely beset with hard bony spines, about two inches in length. The leaves, rather wavy or curly, and pinnately arranged, give to the rather slender recurved frond a plumelike appearance. The fruit-bearing, pendulous racemes, four or five in number, spring forth between the petioles of the outer fronds, under the shelter of spoon-shaped spathas, which seem to be somewhat persistent. The fruit, like a hen's egg, in size and shape, and of greenish orange color, bears in the center a bony seed of the size of a hazelnut. It is an important article of food for the natives, who boil or roast it in hot ashes, and eat it like potatoes, to which it bears some resemblance in taste. An average crop of one tree may furnish from two to three hundred such "*palm eggs.*" Equal in value for the natives is the trunk of the tree, of which the largest did not exceed twelve inches across. The pithy, center portion, is worthless; but the outer ring, of nearly three inches, is exceedingly hard and of great specific gravity, so as to sink in water readily. For these peculiarities, the tree seems to have received its Spanish name.

It is also highly esteemed as larger sized building material, as well as for some minor wood work.

Nearly allied to the Chontaduro is the Pijiguai, which is probably also a Martinezia. Its growth is more stout, but otherwise it resembles much its iron-timbered congener. There are, however, essential differences in the fructification parts of the Pijiguai, which bears more closely packed racemes, with from 60 to 80 plumlike fruits, nearly as large as those of the Chontaduro. The bony seed or kernel is, however, nearly three times as large—that is, about the size of a pigeon's egg. The leathery skin of the rich orange-colored and purplish variegated fruit is rough, and the sweet pulp of the pericarp tastes somewhat like an apricot, which latter is, however, superior in flavor. The timber is used in the same way as that of the Chontaduro. A third form, probably another species of Martinezia, is a palm, which the natives call Mil Pesos, meaning "thousand dollars," on account of an excellent oil which the fruit is said to furnish. The tree was pointed out to us on the banks of the Truandó at some distance. In its external appearance this palm resembles more the Pijiguai than the Chontaduro. Its smaller, and also plumlike fruits, are similarly colored, but are much closer packed—the raceme thus forming almost a pendulous spike. We regret not having been able to examine closer this interesting tree.

Of the unarmed sub-order of Cocoeæ, two forms, probably species of Cocos, L., were observed on the edge of the salt water of both oceans. There were no means of studying the essential difference between both palms except the shape of the nuts, the one having the regular large oval fruit, while that of the other was smaller, and of a more spherical shape. The western limit of vegetation along the tide marks of the Pacific ocean, is found on the Playa of Paracuchichí by a natural fence of lofty cocos palms, apparently of both varieties.

Last, but by no means least, in order to be mentioned here, is another trunkless palm, with pinnate fronds. It is Phytelephas of Ruiz and Pav., or Elephantusia macrocarpa of Willd., which furnishes to commerce the well known "ivory nuts," an important article of export from New Granada, and especially from Chocó. The vernacular names of this plant are, Tagua, Cabeza de negro, (nigger head,) and also Marfil vegetal, in allusion to the peculiar properties of the fruit. This plant seems to abound in the adjacent regions of the Lower Atrato and Truandó, and also on the Nercua. At Cartajena and Sucio, we had occasion to learn that American enterprise is quite largely interested in the shipping of ivory nuts from Cartajena.

BROMELIACEÆ.

Bromelia ananas, L., was observed in its wild state on the Truandó. Br. Karatas, the smallest fruit derived from this species, is brought to market at Cartajena. The natives seem to have a preference for it on account of its agreeable acidity. Of Billbergia, one species was observed. Of Tillandsia, two forms were seen—T. usneoides L., on trees in the everglades of the Lower Truandó, and T. stricta, having an anal-

ogous habitat on the Lower Atrato, and also on the Truandó. The trunks and branches of Crescentia cujete appear to be a favorite resort of these parasites and other vegetable insessores. If we were correct in our observations, one species of a Pitcairnia was also observed within the sections mentioned, which certainly must be considered an open field for plants of this family.

AMARYLLIDACEÆ.

Crinum, sp? Seen in the overflows of the Turbo river. Pancratium littorale, L.? in the same neighborhood. Fourcroya gigantea, Vent. Extensive patches formed by this plant were frequently encountered along the Truandó and Nercua, where they offer serious obstructions to travelers who are bound to go by land. It is one of the "pitas" of the natives, and, on account of its fibers, an important rope plant.

MUSACEÆ.

Of the genus Heliconia, various forms were noticed. Among them, H. angustifolia, H. Bihai, Sw., and H. psitacorum, L. The two latter bear the vernacular names of Vijao, or Vihao, and Ratanillo. Musa coccinea, the Platano guineo of the natives, M. Paradisiaca, commonly called Platano, are both extensively cultivated by the natives, of all colors, along the Truandó and Nercua, and also along the Totumia, on the Pacific side. The importance as food of bananas and plantains needs no special mention here.

MARANTACEÆ.

Two forms of the genus Maranta were frequently observed to adorn, by their gay infloresence, as well as by their showy leaves, the banks of Bas Atrato and the Lower Truandó. If we do not err, one is M. lutea, the Cachibu or hoja de rancho of the natives. Our observations being only cursory, we should not like to venture the identification of other members of this genus, though we are satisfied that several more certainly belong to the flora of Chocó. Another plant of this alliance was seen on the shores of the Nercua, which I suspect to be of the order of Amomaceæ, and, to judge from outside appearance, it may have been a Costus or Curcuma.

ORCHIDACEÆ.

Many and various forms of this interesting family were seen, and partly, also, collected. They may chiefly be referred to the genera of Dendrobium, Sw.; Catleya, Lindl; Bletia, Ruiz & Pav.; Oncidium, Sw., (perhaps O. globuliferum,) called by the natives cebollitas, (that is, little onions;) Spiculeæ? Lindl? Sobralia, Ruiz & Pav.; Vanilla, Sw., (V. aromatica.) Also, a small epidendric form, resembling a Jone of Lindl. We could not ascertain whether the pieces of vanilla, which we saw several times suspended from the necks of Indian boys, either

as mere ornaments, or perhaps as a kind of talisman, were derived from the true vanilla or not. It appears that there are several genera of this order that furnish similar and like sweet scented drugs. Of terrestrial forms, were found two species in the upper sections of the country, one a Spiranthes, L., and the other a member of Lindley's sub-order, Physuridæ.

COMMELYNACEÆ.

Three distinct forms of this order were collected.

ORONTIACEÆ.

From three to four species of Pothos, L. form a characteristic featnre of the undergrowth throughout the lowlands adjacent to the Atrato and Truandó.

PONTEDERIACEÆ.

Pontederia azurea, Sw., with its beautiful flowers, is one of the beauties of the najadic flora of the Atrato and Truandó. Frequently associated with Desmanthus lacustris, it adorns the floating islands upon the former river.

DIOSCORACEÆ.

Dioscorea, L. This genus seems to be well represented all along our line of travel. The yam, or ñama, of the natives, seems to be everywhere cultivated as a staple article of food.

SMILACEÆ.

Various forms of this order were seen, and often encountered as a serious obstacle in our way.

MORACEÆ.

We are not able to say whether that fustic, which is an important article of export from the province of Chocó, really originates from some member of Morus, or must be assigned to some Rhus, Maclura, or even another genus. Of much more value in the national economy of the country is the caoutchouc, large cargoes of which are shipped from the Atrato and its tributaries all the year round. To gather this valuable material, and to bring it into some rude shape for shipment, a large force of laboring hands, of all colors, is employed throughout the whole of the terra caliente of Chocó. The tree pointed out to us as chiefly furnishing the gum elastic along the Truandó, is Ficus elliptica, occasionally forming immense trunks, which, even within the dense forests, can be singled out from some distance. Another large tree form is the Higueron, Ficus glabrata? in Chocó and Cartajena, also called Jagua. It is a large tree, with light, smooth bark

and stately crown. The native travelers, especially the Indians, use its juice to protect their exposed skin against the bites of mosquitoes or gnats. It gives to the skin, however, a very dark, bluish-black color, which lasts for a week or a fortnight after application. Our negro laborers indulged in the innocent pleasure of making their black skins still blacker by means of the Jagua gum. A much richer sport was pursued, however, by the Indians, especially the boys and girls, who often assisted one another in painting upon their skin pieces of apparel, both the essential and the ornamental pieces. Thus these primative children of the woods delighted in having pantaloons, jackets, ornamented belts, breast-guards, etc., without the odium of the burden which real dressing pieces are causing in these latitudes.

One or two climbing species of the Ficus were also observed. They may, perhaps, be F. arboricida, the Higuerote of the natives, and F. dendrocida, the tree or wood killer, or the Mata-palo, or Suan of the inhabitants.

Whether the Lechero, one of the milk trees of Chocó, belongs to the Ficaeæ or not, we are not prepared to say.

ARTOCARPACEÆ.

The Lechero just mentioned may probably belong to this family, and be a *Galactodendron*, Hum., or *Piratipera guianensis*, Aubt. The regidor of Turbo, Se or Casanova, stated that the celebrated Chocó canes, much renowned on account of their hardness and specific gravity so as to sink readily when put in the water, are not derived from a single species, but from various trees, all the names of which he did not remember. Three of these, however, he called "*El Lechero*," *El Capitancillo*, and *El Bordón*. In order to produce the desired hardness and weight of these canes, the natives allow the trees to lie on the ground and to decay; before putrefaction seizes the center portion the outer parts are taken off, when the inside is found with the qualities required.

Cecropia peltata, L., one of the "Palosantos" of the natives, is a water-loving tree of small dimensions and rather depauperate appearance. It is remarkable for its articulated stem, which is hollow between the nodes, and a natural abode of innumerable ants and other xylocolous insects. The Spanish name may have originated from the fact that the aborigines use dry pieces of its spongy wood to get fire from it by friction; in consequence it is looked at as the sacred source of a divine gift. The long-extending almost naked branches of this tree fit it as an excellent lookout for various animals of prey, which are frequently seen perched upon it; as for instance, kingfishers, the anhinga, (Plotus,) and even monkeys prefer to rest on it, because their dreaded enemies, arboreal snakes, cannot easily surprise them there. Guarumo is another vernacular name of this tree.

EUPHORBIACEÆ.

Though this family has its real home in equinoctial America, the number of observed forms is inadequate to what it ought to be in the center of their distribution. *Hura Crepitans*, L. was noticed near Cartajena, next the convent of Santa Maria de la Papa; *Hippomane*

Mancinella L. near the salt lagoons about Cartajena; *Jatropha Manihot*, L. frequently met with either wild or escaped from cultivation. From this plant the celebrated yuca is taken, which is prepared and served upon table like yam. The taste of the former is rather more sweet, but its texture is less coarse. On the commons outside the walls of Cartajena one if not two species of *Janipha* were collected. *Ricinus communis* of L. is also found almost everywhere spontaneously growing. The natives call it Palma Christi, and also *Higuerillo*. Of the genus *Croton* two forms were collected—one a sea-side plant and an old acquaintance of mine from Texas, near Galveston; *C. Maritimum*, Walt. and *C. Eluteria*, W., a small tree on the slopes of the Popa next Cartajena. The *Cedro de Canoa*, which is *C. Lucidum*, L., was pointed out to us from a distance.

CUCURBITACEÆ.

Only two forms seen; one Momordica balsamica, L. grows spontaneously between the shrubbery outside of Cartajena, and a species of Cucumis? which we are not prepared to identify conclusively.

BEGONIACEÆ.

Two or three species of the genus Begonia have been seen in the humid shades along the Truandó. The natives call this plant and its flowers Borlas de San Pedro.

PAPAYACEÆ.

Carica Papaya, L., frequently met with in state of cultivation, under the care of whites, Indians, and negroes.

FLACOURTIACEÆ.

Bixa orellana, L., by the natives called Achote, Achiote, Anoto of the natives, seems to be quite common along the Truandó. At Turbo we also found it in gardens for the use of the kitchen. The Indians use the seeds to paint their skin red as a palliative against the bite of mosquitoes, a habit for which the Castilian language adopted the verb "anotarse." Internally the seeds are used as a tonic and against fever. The word bixa or bija, according to Humboldt, belongs to the aborigines of Hayti. The Tamanac Indians of the continent call the tree majepa.

PASSIFLORACEÆ.

From five to six species were observed and collected; three at Cartajena, of which two may be referred to Passiflora fœtida and P. Minima. Two are very common on the banks of the Atrato, one with pure white and the other with bright blue flowers; but above all is one of surpassing beauty, with large scarlet flowers nearly four inches in diameter. It is a fructicose climber, with an eatable fruit of the size of an apple. We saw it at Turbo and along the rivers Truandó and Nercua. According to outside appearance it is allied to P. *Murucuja, L.*

MORINGACEÆ.

Moringa polygosperma, Burm. This foreigner on American soil was found in one of the gardens of Cartajena, growing lustily, in a genial sea-side atmosphere.

STERCULIACEÆ.

Of the genera Eriodendron, D. C., and Bombax, L., two or three species have been observed; among them that well known tree giant, B. Ceiba, L., which, not only on account of its gorgeous dimensions, but by favoring a large host of parasites and epiphytes growing on its trunk and branches, may justly be considered as one of the patriarchs of the South American forests. There is a buff colored, short fibered cotton in use for stuffing pillows and cushions, which comes from one Bombax. We had, however, no opportunity of identifying closer the tree itself. For want of cohesion between the fibers, this cotton seems to be unfit for manufacturing purposes. We take occasion to here express our astonishment about Mr. J. C. Trautwine's remark, in his "Rough Notes of an Exploration for an Interoceanic Ship Canal," &c., (see page 2,) where he uses the following words: "Still I do not remember to have seen a single large tree growing throughout the entire course of the Atrato." Either Mr. T. or ourselves must have had a different standard of judging dimensions of tropical trees; or those gigantic Ceibas, Robles, Cedros, Trementinos, and other large trees, especially of the leguminous order, which are arrayed on both sides of the majestic Atrato, must have grown up since Mr. T.'s visit in 1853. There stands a large Ceiba in the outskirts of Turbo which can be singled out by its gorgeous growth almost from the middle of the Bay of Urabá. At Sucio, close to the landing, is leaning against the river banks, with its main portion submerged, the broken trunk of a Ceiba, which we measured as closely as possible, and found to be of between ten and twelve feet in diameter. The trees mentioned by their vernacular names are those especially looked for by the natives, who cut out from their trunks those well known canoes. One of the latter, measuring thirty-seven feet by three, was purchased for the use of our party. The Indian who sold it to us had worked it out of a single block of a so-called Cedro, which certainly must have deserved to be called a large tree.

Carolinea princeps, L., is a middle sized tree on the banks of the Atrato, remarkable for its elegant flowers, which often measure from eight to ten inches in length. It probably received its Spanish name, "Arbol de Pan," on account of its large, leathery capsules, of the size of a child's head. These large capsules, suspended from the slender branches of the tree, and of a brown color, appear really like so many loaves of bread. This tree, which our negro laborers called also "Salero," descends clear down to the lower tidal limit.

BYTTNERIACEÆ.

Theobroma Cacao, L. This useful tree is frequently seen near the settlements. The Cacao of Chocó is much esteemed, and its qualities

classed with that prime article which comes from the Magdalelena river. At Cartajena, two steam manufactories are at work almost exclusively for the home consumption of the "Magdalena Chocolate."

A second species is Th. vicolor, which furnishes a delightful fruit. The rich orange-colored pulp in which the seeds are imbedded, is much cherished by the natives, who call it "Bacao," also "Bacao de Chocó." Another species is the Guazuma, L., sometimes also called "Madroño." If we do not err, this species furnishes a tough fiber for cordage, much looked for by the natives.

MALVACEÆ.

Quite a number of weeds and more prominent herbs have been noticed, which may be referred to the genera of Malva, L.; Malvastrum, Gray; Sida, L.; Abutilon, Tourn.; and Sphæralcea, St. Hil.? Of Malvaviscus, a tree form was often met with in the river thickets along the Truandó and Atrato. This tree bears a conspicuous, pink-colored blossom, and may be M. arborea, Canan. or Hibiscus malvaviscus, L. In one of the gardens of Turbo we met a beautiful variety of Hibiscus esculentus, bearing atropurpureous blossoms. More important, however, for the economy of the country, is its arboreous cotton plant, Gossipium arboreum, L. It can be seen in almost every garden at Turbo, where it principally furnishes to the inhabitants the domestic complement of raw cotton. Another species of Gossipium is in use with the people of Chocó, but we could learn nothing about the identity of the plant, or the merit of its fiber.

TILIACEÆ.

A tree was met with on the Atrato, and lower Atrato, which must be closely allied to, if not identical with, Luhea divaricata?

POLYGALACEÆ.

Only one very inconspicuous species of the genus Polygalaceæ was found upon the rocks of the Truandó Falls. Its affinities place this little weed near P. Verticillata, L.

SAPINDACEÆ.

Our natives talked much of the soap tree being of frequent occurrence within the forests along the Nercua and Truandó, but we could not succeed in being personally introduced to one single specimen, though there is no doubt that some Sapindus could be found in these localities. Various members of the genus Paullinia, L., may be obtained here.

MALPIGHIACEÆ.

Of the genus Malpighia, one or two forms were seen adorning the banks of the Atrato, and also one species which may belong to the

genus Janusia. Of the genus Banisteria, beautiful climbers were also observed.

A fruit called "Cereisa," in the Cartajena market, may also be referred to this family. The outside appearance of it is much like cherry, but the stones or kernels in the center prove its malpighiæeous relation, and may be referred to some species of Birsonima.

CLUSIACEÆ.

Mammea Americana, L., the Mamei of the natives, is a well known desert fruit, sometimes very common in all the fruit stores of Cartajena.

Our mode of traveling and working through the forest of Chocó did not admit of a more careful gathering of botanical treasures. Thus this tropical family of America is not represented in our collection.

MARGRAVIACEÆ.

This exclusive tropical American order furnished one member to our collection. Ruyschia Amazonica is a climber quite common on the banks of the lower Atrato.

NYMPHÆACEÆ.

Though this order is at least numerically very well represented throughout the aquatic regions of our route, we succeeded in getting to hand but one species of the genus Nymphæa.

ANONACEÆ.

Anona Humboldtiana, the Chirimoya, and A. muricata, the guanabana of the natives, are well known, as they furnish highly esteemed fruits to the otherwise well supplied tropical markets. Unona xylopioides we found growing on the slopes of the Popá next Cartajena. The fruit is little complimented by its popular name, Fruto de burro, (fruit of the donkey.)

CEDRELACEÆ.

Swietenia mahagoni, the Caoba of the natives, is said to abound through the regions of Chocó. None of our party, however, succeeded in seeing in situ a specimen of this remarkable species, which also forms an important article of export from New Granada. A species of Cedrela was pointed out to us on the banks of the Atrato, where it seems to be of common occurrence. This tree occasionally grows so large that its gigantic trunk often furnishes the material for Indian canoes. If we were correctly informed, the fragrant wood of the same tree.is used by the natives for cabinet work, and especially for making cases and trunks. Its heavy odor probably keeps off noxious insects from the contents of such cases. The latter forms a regular market article in Cartajena. The wood itself is of a reddish hue.

MELIACEÆ.

Only one specimen of his order was identified as Melia Azederah, L., the arbol deparaiso of the natives who, in their easy way, cultivate it as an ornamental tree in their semi-wild gardens.

ANACARDIACEÆ.

The fruit of the Cashew tree, Cassuvium pomiferum, is a much cherished market article in Cartajena. No other members of this order have been noticed.

SIMARUBACEÆ.

Simaba cedron, the Cedron of the natives, was seen near Turbo, on the gulf of Urabá. The medical virtues of the colytedons of the fruit received in later times some note as an unfailing remedy against fever, and still more as an antidote against the bite of poisonous reptiles. The fruit sometimes is brought to market in Cartajena, where it also seems to be an article for the drug shops.

ZYGOPHYLLACEÆ.

Only one species belonging to this order was seen. Kallstrōmia sp.? is a common weed about Cartajena.

PORTULACACEÆ.

The Verdulaca of the natives is a species of Portulaca, probably identical with Sesuvium portulacastrum, L., which belongs also to the flora of lower Texas.

POLYGONACEÆ.

Of the genus Polygonum various species have been observed, most of them mere weeds, not inviting special attention. There are one or two species along the banks of the Atrato and Truandó, where they form, together with some Panicum, immense patches on the overflows of these rivers. The natives call them Tabaquillo, or Tabaco de Agua. The species may be referred to P. Segetum and P. Hispidum. Another Polygonate was seen and much admired in the gardens at Cartajena, where it is allowed to climb and cover the old walls of the houses and fortifications. For the beautiful rose-colored racemes which this shrub bears in innumerable clusters, it is called Belissima. Seeds which I brought home germinated freely, but the young plants, in the public gardens of Washington, where they were placed, died one after the other. This plant, for its surpassing beauty, well deserves the attention of horticulturists.

Coccoloba uvifera, L., the Agraz of the natives, is an arborescent sea-side shrub, common about Cartajena, especially on the island called Tierra Bomba. It is not improbable that another species of this genus

may be identified by further examination. Of the sub-order, Triplareæ, a remarkable tree of the genus Rupprechtia, Meyer. was observed. It is not very large, but upon its straight articulated stem an elongated crown is placed, which, after blooming, is clad with an intense scarlet hue, as if representing the burning bush which once appeared before the sight of Moses. The natives call this tree also Palosanto, probably on account of its resembling externally the Cecropia peltata.

AMARANTHACEÆ.

One species of Achyranthes and one of Gomphrena were recognized about Cartajena.

PIPERACEÆ.

From four to five distinct species of this order were collected near Turbo, and also along the Truandó. They got lost, however, afterwards, by some unavoidable accident. These climbers appear associated with some forms of Filices, Pothos, and other Epiphytes.

LAURACEÆ.

The Ahuacate of the natives, or the alligator pear tree of English and American travelers, is Laurus Persea, L., and a well known fruit tree of equinoctial America, where it follows man everywhere. The northernmost limit of this species we observed during our travels in the Mexican State of Cohahuila, in the mining town of Santa Rosa. On the Pacific slope of this continent the Ahuacate, in all probability, may go to a still higher latitude.

CHRYSOBALANACEÆ.

Chrysobalanus Icaco, L., furnishes the highly esteemed Icaco plum of the West Indies and the adjacent regions of South America.

LEGUMINOSÆ.

Upwards from humble aquatics, shifting their habitat with the changing course of rivers to gigantic forest trees, with hosts of epiphytic guests, every shape of vegetable life seems to be represented by members of this vast order. The genera Tephrosia, Desmodium, Canavallia, (C. obtusifolia,) furnish some of the weeds of the sea-side growth about Cartajena. Shrubs and small trees of the same locality were observed to belong to Inga, Algarobia, Parkinsonia, and Acacia. Of the three latter the species may be justly referred to A. glandulosa, P. aculeata, and Acacia Cavenia. Cultivated and spontaneously growing were found there a Tamarindus and a Poinciana, (P. pulcherrima,) which latter bears the popular name Flor de Angel, and also Flor del Muerto. Through the forest along the Atrato and its tributaries the variety of podbearers increases almost with every step. Of the sub-

order Papilioneæ some beautiful vines were noticed. They may belong to the genera of Clitoria, Dolichos and Phaseolus. Another vine of this group was seen bearing racemes of large yellow blossoms, each one measuring more than two inches in length. With flowers of almost equal size a tree was observed at the Truandó falls. The flowers, like those of the Cacao, spring forth from the blackened bark of the trunk and the main branches of the tree, a peculiarity which it has in common with another tree of the groupe of Cæsalpinieæ? called by the natives Clavigeno. We often observed a large compact cluster of blossoms, unaccompanied by any leaves, breaking out from the trunk not two feet above ground. The flowers by their rich scarlet color and by their long exerted stamens much resemble those of Poinciana pulcherrima, from which it is, however, easily distinguished by the size and the straight growth of the tree, as well as by its large lanceolate leaves. The wood, we were told, is very hard, and eagerly looked for by the natives for making canes. The inhabitants about Medellin call this tree Ariso, if we were informed correctly. Of the genus Inga two or three forms were encountered; one with bright, broad green leaves; the Indians eat the pulpy pods. The Guamo proper (I. Humboldtiana) is found occasionally planted in the gardens of the inhabitants. Of the genus Mimosa several interesting forms were seen. From the sensitiveness of their leaflets the Spanish-speaking natives call them generally Dormideras, Sensitivas, or Vergonzosas, which names are, however, also given to other members of the mimosaceous group showing like irritability of their appendicular organs. Very remarkable on account of the extraordinary size of its falcate pods is Mimosa scandens, which seems to be quite common along the Atrato. The length of one of these pods was measured to be more than 20 inches and nearly 3.5 inches broad. Nine large kidney-shaped beans, each two inches broad, were found imbedded in this monster pod. Some years ago, while in camp on the mouth of the Bravo del Norte, beans of this same species were thrown ashore at that point by the tidal surf. This invited my special attention in regard to the workings of the gulf stream, which is carrying tropical fruits into other latitudes. Of late, however, I was more surprised at learning that one of these mimosa beans had been received at the Smithsonian Institution from Nova Scotia, where it had been picked up on the beach among other sea-side deposits. On the Texian coast these beans in company with others, especially the seeds of a Stizolobium, are brought along regularly by the gulf stream. Of the genus Stizolobium, or Mucuna, one if not two species have been observed along our line of travel. The plant seems to belong to both sides of the continental relief. Among the larger forest trees is the so-called Trementino, which is most common. The tree bears a large lunate or cresent-shaped monospermous pod; the shining leaves are arranged in pairs, (zygophyllous;) the trunk is very straight, forming an almost branchless column covered with a light brown bark, strips of which the natives employ as cordage. The tissue of its white wood is replete with a greenish white aromatic gum, which probably gave rise to the name of the tree; for Trementino is, beyond doubt, nothing but a negro corruption of the Spanish terebintina, which means turpentine. The botanical affinities bring this tree near Hymenæa. or

Cynometra. Of the genus Abrus one species was found on the Truandó, where it appears sporadically in large numbers. The species, if not identical with A. Precatorius L., must come very near it. Willdenow's genus Desmanthus appears very neatly represented upon the waters of the Atrato and Truandó by a somewhat najadic member of the river flora. D. lacustris, associated with Pontederia azurea and an Ultricularia, besides other water plants, adorns the floating islands of these rivers, and also those places where the water is stagnant behind projecting river banks. Of the genus Cassia, an arboreal beauty appears to be quite common on the Atrato. It is not of much size, but bears a dense flatly-expanding crown, which is richly festooned over by hundreds of large racemes, (nearly two feet in length,) bearing bright orange-colored blossoms. We had not the good fortune to find this tree in fruit; but, to judge from outside appearance, it may be identical with C. Fistula, L., of which we saw a fine specimen in the courtyard of the old convent of San Agostin, now the University of Cartajena. The large pods of this Cassia are a common article in the fruit stores of this old town, where it is sold under the name of fistola.

LYTHRACEÆ.

One or two forms belonging to the genera Cuphæa and Diplusodon? were found upon the rocks at the Truandó falls. Both plants are suffruticose, and offer but little interest.

SAPOTACEÆ.

The fruits of Achras Sapóta and Chrysophyllum Cainito, L. are well known desert delicacies of the West Indies and tropical America generally. The Sapote or Níspero of the natives is of the size of a small apple tree, with a spreading crown and more straight growing branches. We met fine samples of it about Cartajena, especially on the heights of the Popa. The cainito, or, as the negroes call it, caimito, was observed in the lowland forests about Turbo.

APOCYNACEÆ.

Various plants belonging to this family were observed, especially along the banks of the Atrato, to the vegetable adornment of which they contribute in some instances very considerably. The loss of the principal portion of our Phanerogams deprived us, however, of the opportunity to closer identify some of them. Plumieria alba, or, perhaps, acuminata, was frequently found about Cartajena, where this ornamental tree is called Árbol de Azahar. Slips of it were given to me for taking them north, but the rats on board the vessel on which we returned to the United States greedily ate them up, not even leaving the underground portion of them. The ladies of Cartajena place the flowers of this tree between linen, to communicate to it the fine odor of the blossoms. Other apocynaceous plants which have come to our notice may belong to the genera Taberna, Montana, Cerbera, and perhaps Rauwolfia.

LOGANIACEÆ.

A small herb under the name Vermifugio, was pointed out to us in the wood about Turbo. To judge from very depauperate specimens, this anthelmintic may be referred to some Spigelia, perhaps Sp. anthelmia, L.

SOLANACEÆ.

Various forms of this large family came to our notice. Among them, Solanum esculentum? a shrub from five to six feet high, near Turbo. The natives, who eat the berries of it, call it Lulo. A capsicum closely resembling C. microphyllum, Duval. was found in one of the gardens of the Chocó Indians, on the Nercua. Datura Tatula and D. Metel were also observed. Of the genus Physalis, one form was collected; of Nicotiana also one; both spontaneously growing.

CONVOLVULACEÆ.

Few members of this order were observed. In the thickets covering the hill slopes of the old fort San Felipe, at Cartajena, a shrubby, somewhat arborescent species of Convolvulus was seen. It is remarkable for its large showy flowers at a season of general drought, at the close of the dry season in March and April. Another species of the same order was found at the mouth of the Nercua, forming immense mats over fallen timber and crumbling river banks. We were not able to distinguish it from C. purpureus, L. On the sea-side at Cartajena, a species of Batatas, Chois., was recognized as identical with one occurring at the mouth of the Bravo del Norte, which is B. littoralis, Chois. One form of Pharbitis was also collected in the surroundings of Cartajena. Another interesting form of this family, apparently rare, was collected on the sandy places along the Upper Nercua. The scarlet Ipomæa quamoclit, was also observed near Cartajena.

LAMIACEÆ.

This family was found but poorly represented along our route. One single mentha was taken up, and a few others, being known as garden herbs, were occasionally found, having escaped from their places of cultivation.

VERBENACEÆ.

Besides various inconspicuous weeds of the genus Verbena, one prominent form, with a large practeate spike and dark blue, almost black, blossoms, was found on the hill slopes of Fort San Felipe, at Cartajena. Having no means for closer examination, we abstain from mentioning even the genus to which this plant may rightfully be referred.

MYOPORACEÆ.

Avicennia tomentosa, Jacq., and we believe A. nitida, belong to the salt swamp flora of Cartajena and the Tierra Bomba. The natives

distinguish both species as Mangle blanco and mangle prieto, (black and white mangrove.) Both seem to be employed for tanning, and much of it is exported from this place.

PEDALIACEÆ.

Only one member of this order was observed, and this was in all probability introduced. One specimen of Pedalium murex? occurred in the garden of a Chocó Indian, at Camp Tocamé, on the Truandó.

GESNERIACEÆ.

Three species of the genus Colmunea were collected on the Truandó, where they, as epiphytes, appear associated with various Orchidaceæ, Filices, Piperaceæ, Bromeliaceæ, &c. The hairy leaves of these columneas often showed as bright colors as the blossoms. Thus they become quite showy, even at a distance.

CRESCENTIACEÆ.

Crescentia cujete, the well known calabash tree of tropical America, is found everywhere near inhabited places. Its long, undivided branches, with its small fascicled foliage, this otherwise poor looking tree is resembling the Fouquiera of the western deserts of North America. The tree is also remarkable for its apparently favoring epiphytic and parasitic plants, of which, in certain localities, often a very large variety is found adorning the branches of this tree.

BIGNONIACEÆ.

This family of vegetable Belles is of course very fairly represented all along the route. Among the more prominent forms are Bignonia echinata, near Turbo; Tecoma pentaphylla, the Roble amarillo of the natives. It is a bold, lofty tree, bearing some resemblance to a full grown oak. There are, besides Tecoma stans, three other varieties of the same genus.

ACANTHACEÆ.

Various forms were seen along the Truandó. Among them, two species of Aphelandra, one probably A. cristata, near Cartajena, on the hill sides of the cerros La Popa and Pelado. By their natural affinities, one may be closely allied to Drejera juncea, Torr., and the other much resembles a species of Dicliptera? which I had collected previously at the town of Magdalena, in the State of Sonora, Mexico.

LOBELIACEÆ.

Only one specimen of the genus Lobelia was collected on the banks of the river Turbo. We could find no essential difference to distinguish it from L. Surinamensis.

ASTERACEÆ.

This large natural order was found poorly represented through the regions adjacent to our line of travel. Among the weeds, which deserve here no other but botanical notice, a small form of a Conoclinium, allied to C. betonicum D. C., was found upon the rocks at Truandó Falls. The most important of this family, however, is the celebrated Guaco of the natives, which is a Mikania, also enumerated in General Mosquera's essay as M. Guaco. Our negro and zambo laborers pointed out to us numerous forms of what appeared to be the same species. The only difference among them was the color of the leaves, which in some instances appeared variegated by brown, purple, and white colors along the veins. Each one of our natives who had an empty bottle at his disposal gathered some of the leaves, to preserve them with a little agua ardiente. This infusion they consider not only as an unfailing antidote against the bite of venomous reptiles, but also as an arcanum in cases of calenturas, (slight fevers,) and other evils which befall travelers in these regions. Fortunately, none of our party was forced to test the virtue of the plant. The vernacular name Guaco, is also given by the natives to some species of Aristolochia, and the medical properties which science until now has really recognized in this drug, may belong to the latter. The Cartajenian pilot being in charge of the nautical Lookout at that port, and who resides at the old convent on the Popa, once handed to me a crippled specimen of an Aristolochia, giving at the same time a pharmaceutic eulogy on the plant, which he also called Guaco. The Guaco of Cuba seems beyond doubt to be a species of the same genus. The name guaco does not appear to designate one certain plant, but various plants, having in common, perhaps, certain medical properties.

RHIZOPHORACEÆ.

One form of the genus Rhizophora was observed to principally constitute the mangrove thickets about the bay of Cartajena, as well as in the Gulf of Urabá and in the Bahia Ensenada, on the Pacifican terminus of our route. In the latter locality the usually small tree attains considerable size, and gives to the mangrove section there a grand character. The species is Rh. Mangle.

MELASTOMACEÆ.

From two to three or four forms belonging to this order were observed along the Upper Truandó. No special attention, it appears, is shown this order by the natives.

MYRTACEÆ.

There are two or three species belonging to this fair family which we noticed round the settlements of the natives. They are Psidium pomiferum, L., and Ps. pyriferum, L., which, botanically, may not be much distinct from each other. The former is called by the natives

Guaiaba, and its congener, guayabilla. Another form is Eugenia Jambosa, the celebrated "Pomarosa" of the natives, so called from the rose-like flavor of its eatable fruit. A fourth form was observed in the thickets on the hills-lopes of Cerro Pelado, near Cartajena. We are also not yet able to nearer indentify this species. At the Truandó Falls one of the Chocó Indian boys brought along the branch of a tree with ellyptic lanceolate mucronate leaves, which were very fragrant, like cloves. This may possibly have been an Eugenia, perhaps E. caryophyllus.

LECYTHIDACEÆ.

At Turbo we picked up the globular pericarp of a tree, which we thought to belong to Couroupita guianensis, the so-called cannon ball tree. We had no means to identify, even on the spot, the tree from which the fruit had come down, such are the difficulties in the dense, often impenetrable shadows of tropical forests. Of Lecythis ollaria, we often found its singular shaped fruits without being able to get a closer sight of the foliage and ramifications of the tree itself. Two species of Lecythis, however, could be recognized, one L. ovata, Aug. de St. Hil., and another forming, like the former, a small tree with large dark green club-shaped leaves, which are all crowded towards the end of the branches, and there form a sort of a facette, in the center of which its gigantic rose-colored blossoms are sitting. Several of the latter were found to measure from six to seven inches in diameter. The natives call this tree Membrillo, though it bears in no respect resemblance to its northern namesake, which is Pyrus Cydonia, L. The fruit contains a number of nuts, which the traveling Indians and negroes eat like the real bread-fruit. We found their taste rather indifferent, followed by some little astringency. On account of its beautiful flowers this species, which is perhaps L. grandiflora, Aubl., is really one of the floral wonders of tropical America. We have to regret, however, the impossibility of preserving at least some what of the beauty of our dried specimens.

LOASACEÆ.

This order, which seems to have its principal home in the dry, arid regions of northern Mexico and the deserts of western North America, furnishes us only one species, which grows on the barren tertiary hill slopes about Cartajena. If we do not err, this plant must be identical with Cevallia sinuata, Loq., a plant frequently collected by the Mexican boundary survey.

CACTACEÆ.

On the arid tertiary hills lopes about Cartajena this family is well represented by three prominent forms. Two belong to the genus Cereus, and seem to be the same which Linnæus mentioned long ago as occurring in this neighborhood. One is C. Peruvianus, which grows here to a height of from twelve to fifteen feet. It is a bold form, and

almost exclusively covers the top of the Cerro Pelado, giving this hill, even from some distance, quite a peculiar appearance. The natives call this plant El Cardon. The second species is C. triangularis, which is probably identical with Cactus erectus triangularis of Jacq. It grows nearly to the same height as the former, but forms only a few very slender shoots. The natives, we were informed, occasionally use strips of this plant cut open as cataplasms. The third cactus form is an Opuntia, the identity of which we have not been able to determine yet. Its large flat joints bear on their areolas from one to three dark brown somewhat twisted spines, one or one and a half inch in length. It bears a large egg-shaped fruit of a very dark brown red color. There is scarcely any doubt that these tunas are eatable, but in a place where they would have to concur with oranges, guavas, ahuacates, nisperos, and a very large series of other more delicious fruits, no one seems to look after tunas.

In the forest regions along the Atrato and Truandó two forms of the sub-order Phyllanthidæ were observed as epiphytes on high lofty trees, where they appear associated with various ferns, bromelias and other plants sharing a similar mode of life. Hanging down from the branches of trees, and resembling somewhat certain pendulous ferns, these two cacti bear also the same vernacular name, Rabo de babilla, which means tail of the babilla, (one, of the feathered banana thieves of the country—Cassicus cristatus?) The two cacti belong to the genera of Phyllocactus of Link, and Epiphyllum of Lindley.

CINCHONACEÆ.

Of this important order our collection has but little to show. For the valuable cinchonas our route did not ascend enough. Besides four forms of indifferent weeds from the neighborhood of Richardsonia, Diodia, and nearly allied genera, we only have to mention Coffea Arabica, which we saw cultivated on the Turbo river; the plantation being just established, nothing could be learned about the nature of the crops, which may resemble, however, those of other localities on the northern coast of South America.

CAPRIFOLIACEÆ.

One species of Sauco, which is the Spanish for Sambucus, was pointed out to us at Turbo. The shrub, however, bearing them neither blossoms nor fruits, could not be identified; not even in regard to its natural order, which is generally but scantily represented within the tropics.

ARISTOLCHIACEÆ.

Under the head of Asteraceæ, we mentioned a species of the genus Aristolochia, which was found on the hill of La Popa, and is said to generally abound in the thickets around Cartajena.

The species may be identical with A. anguicida, L., to which Linnæus, in his Regnum Vegetabile, adds D. Jacquin's note, as follows:

"Succus radicis saliva mixtus, gtj-gtj, ori serpentis instillatus, facit ut toto tractetur post horas aliquot redit ad se."

With this, no doubt, Jacquin seems to recognize the statement of the popular Materia Medica, in regard to the plant, which we do not hesitate to consider as the true and original Guaco of the Cartajenians and the West Indies generally.

XII.

APPENDIX E.

ZOÖLOGY.—MAMMALIA.

BY A. SCHOTT.

The list of Mammalia which, during our sojourn across the Isthmus of Chocó, have come to observation, though small, and in regard to systematic identification deficient, may nevertheless enable the reader to complete and enliven in his mind the physical picture of the country here treated upon. We certainly for the sake of science would have preferred to offer in these pages an authentic enumeration of all the species; but having had no opportunity of comparing our collections with well-established South American species, it was decided, after conferring on the subject with Professor S. F. Baird, of the Smithsonian Institution, to omit for the present a strictly systematic account of our mammals until they could be more successfully studied under more favorable circumstances.

The subjoined nomenclature is only intended to name the species provisionally, as far as their affinities would justify to do so. This is especially the case with the most difficult order of the Quadrumana, the study of which almost indispensably requires the personal acquaintance with the living and not even expatriated animals.

QUADRUMANA PLATYRHYNÆ.

Sapajous of Buffon.

Gen. MYCETES, Illig. STENTOR, Cuv. Schinz.

M. SENICULUS, Vruhl. Mono Colorado of the natives; Roaring monkey of English travelers; Rother Brullaffe of the German; Alouatto of Buffon.

This species seems to be most common in the delta and overflowed regions of Bas-Atrato and Truandó. Its peculiar cry so closely resembles the distant roar of a heavy surf, that our whole party, on hearing it for the first time, was deceived in that way until the natives informed us of the truth.

No other species of the four-handed order was found so near the tide waters as the roaring monkey, of which five specimens, one female and four males, were procured for the collection.

M. Beelzebub, Lessor?; Mono zambo or Mono miedoso of the natives; Schwarzer, Brullaffe; Waldtesfel of the German; Warine of Buffon.

A generic akin to the former and much like it in size, form, habitat, and mode of living. It is also of similar shy, untamable, downward temper, which makes it one of the most savage of this generally vicious and mischievous family. The intellectual deficiencies of this species seem to have caused its Castilian epithets.

Gen. Ateles, Illig. Cuv. Schinz.

A. Paniscus, Geoff.; Caita of the French and English, also four-fingered monkey of the latter. Schling. Klammer, or Spinnenaffe of the German.

We saw one live specimen of this apparently gentle species as a pet passenger on board a native barge, upon which a detachment of our party returned to the Gulf of Urabá. According to the statement of the natives, this animal seems to be not uncommon through the wilds of Sucio and the middle and upper Atrato. On our line of travel none of the species was seen.

Gen. Cebus, Erxl. Sajou.

C. Chiropus, Mosquera? (Pithecia leucocephala, Geoff?) Mono cara blanca, also Carita blanca of the natives; Weeper or Howler of the English; Rollaffe or Wickelschwanz of the German; Sajou of the French; Sai of Buffon.

Love for fun, which this species exhibits everywhere and with untiring vivacity, gives it with almost every traveler a certain well merited preference. Less shy than their wild Mycetes relations, the white-throated sajons seemed always delighted if some news turned up along the shoreside of the Atrato. Whenever a canoe or passenger boat appeared, they followed it often for a considerable distance, jumping from branch to branch on overhanging trees. On such occasions they also presented to us that singular trick of swinging themselves suspended by the tail like a pendulum, in order to reach another point, whenever they found the distance too great for a regular "salto."

I do not recollect of having ever heard the cry of this animal, which probably gave rise to its English names.

Three specimens, two males and one female, were secured for the collection.

Sagoins of Buffon.

Gen. Callithrix, Erxl. Cuv. Schinz.

C. Sciurea, Erxl.; Simia redipus, L.; C. redipus of others; Titmi of the Cartajeños; Echhornaffe of the German; Squirrel monkey of the English; Le Pinche of the French; the Pinch of Buffon.

The various names sufficiently characterize the peculiarities of this

well known species, which is the most delicate form among the monkeys on the isthmus, at least so far as our observations reach. The docility of these little animals makes them pretty generally the favorite of the people, and they are therefore frequently brought to market for sale.

Gen. PITHECIA, Desmarest; Schweiffaffen of the German.

P. hirsuta? of Spix. (P. nocturna? Less.;) Gusagusa of the Chocós; Marta or Mata of the Cartajeños; Zottelaffe of the German.

Coarse, somewhat woolly hair, short tail and and large, black, dull looking eyes, which are very much convex, and strongly protruding from their sockets, are the principal external characteristics of this animal, the general aspect of which lets one suppose that it is of nocturnal habits.

I only saw one freshly killed female specimen, which our zealous chief, Lieutenant N. Michler, afterwards purchased for the collection. According to the natives, this species is not uncommon in the region bordering the Sucio river.

CHIROPTERA. VESPERTILIONIDÆ.

Of this group two or three specimens were obtained at Cartajena. Their specific affinities have not yet been ascertained on account of the difficulties mentioned above.

Of the much dreaded vampyres, the acquaintance of which has been promised to us by Mr. W. Kennish, the worthy discoverer of the Truandó route, and this time the guide of the party, we did experience not the slightest inconvenience from these nocturnal evil-doers, nor did we see any of them to our knowledge.

CARNIVORA. FELIDÆ.

FELIS CONCOLOR, L.; El leon of the natives; Puma Cuguar, Pagu, Chimbica, Yutin, Mizttli, are the animal's names, derived from various Indian languages of South and North America; Panther of the Anglo-American, sometimes Painter, a corrupt form of the English inappropriate name.

One large specimen of this powerful cat species was seen at daylight in the forest region of the Palisades on the Truandó. Its unmistakable cry was often heard, especially through the more elevated portions of the country. No specimen obtained.

F. tigrina? of Less. El tigrillo or gato tigre of the natives; Maragua of Buffon.

At Cartajena I purchased the fur of what I suppose is to be referred to this species. This animal is smaller than the ocelot, (F. pardalis,) but resembles it much in the beautiful color and design of the fur. Though none of the party succeeded in seeing a live specimen of this species, we have no doubt that this must be the very species hanging around our night camps on the rivers Truandó and Nercua. Its weak

feline cry was often heard right near, and in one instant even one of our assistants saw for one moment its lucid eyeballs fixed towards camp.

RODENTIA. SCIURIDÆ.

Of this order one or two, if not three, species were secured along the Bas Atrato, the Truandó, and Nercua; one male on the former river, one on the Truandó falls. Higher up two females were added to the collection, and also one pair of a little species somewhat like Tamias.

CAVIDÆ.

Gen. CAVIA, Klein; C. CAPYBARA, Schreb; HYDROCHOERUS CAPYBARA, Cuv. Lancha or Lanchos of the natives; Wasserschwein of the German.

At Sucio one apparently full grown female specimen was obtained for the collection. Unfortunately the hogs of the place, though domesticated, but less scientifically disposed, had commenced to prey on the skin, already cured with arsenic and spread out in the open air to dry. Though almost instantly recovered from them, the scientific object was found to be minus one or two feet.

Gen. DASYPROCTA, Illig.; D. AGUTI. Guagua of the natives.

One specimen of this animal was received also at Sucio. The animal is said to be quite common all along the route, but by being of nocturnal habits it escaped our attention. At Turbo a live specimen was brought aboard and kept for a few hours, when it escaped by jumping over board, and resolutely made for the nearest point of the Atrato delta, which it undoubtedly reached in safety.

EDENTATA. EDENTATA.

Gen. MYRMECOPHAGA; M. JUBATA, L., Illig. Oso hormiguero of the natives; great ant-eater of the English; Grosser Ameisenbær of the German.

One skin was obtained from some Indian hunter. It was not prepared however, only imperfectly cured afterwards, and consequently damaged. According to the natives, these singular and useful ant destroyers prefer ground a little more elevated.

TARDIGRADA.

Gen. BRADYPUS, L., also ACHEUS of others. B. tridactylus? Acheus Ai. of others; Perico lijero of the natives; Sloth of the English; Faulthier of the German.

Several samples of this species were observed in various localities on the lower Atrato. They were usually seen clinging to small trees of

arbuscular growth. Three were killed, but on account of the inaccessible localities only one could be secured. It is curious that they all had been seen hanging on some species of Caladium, probably C. arboreum, a very poisonous acrid plant. Whether these, from nature, seemingly neglected animals, really feed upon the broad leaves of this lacustric plant, I am unable to say. The Spanish name of the animal is chosen most appropriately, for the main portion of it is a thick fur with coarse brittle hair; muscle and bone are of comparatively very little weight, the latter almost as light as fish bones. This want of gravity, however, enables the animal to bear its life of unceasing suspension so much the easier.

PACHYDERMATA. SUIDÆ.

Gen. DICOTYLES, Cuv.; D. LABIATUS, Cuv. Sajino or Sajina of the natives; Tajassu in other parts of South America; also Peccary of other countries; Javalin of the inhabitants of the lower Bravo del Norte; White-lipped peccary of the English; Weisslippiges Nabelschwein of the German.

This species seems to be quite common through all the lowlands of the isthmus, and was seen several times in large droves. As it is eagerly hunted for by the natives, it has become very shy. The comparative scarcity of snakes which we noticed along the route, is probably the work of the peccary. Some of the natives attribute the carate, and indigenous cutaneous abnormity to which their people are subject, to an excessive use of this animal's meat. D. torquatus, the collared peccary, which is the Tatabro of the natives, is said to prefer more rising ground.

TAPIRIDÆ.

Gen. TAPIRUS, Briss. T. americanus? the Danta of the natives; according to Azara, the Mborebi of the Indians in other parts of South America; also Maipuri of others.

According to its numberless tracks, which we could observe almost everywhere on the line, especially along the Truandó and Nercua, this animal must exist there in considerable numbers; still none of the party has been so fortunate as to have a glance at one. The cry of the animal, to which the natives often called our attention, is a long continued whistling, almost as powerful as that of a steam engine, to which it may be well compared. No evening passed on the Atlantic side that we did not hear this natural signal, our "tardoo" in the wilderness.

MANATIDÆ. (CETACEÆ OF OTHERS.)

Gen. MANATUS, Rondelet; also L.; M. AMERICANUS, Cuv.; (Trichecus manatus of others;) Manati of the natives; La mantin of Buffon.

Though we were told that this animal abounds in the Atrato delta, and also for some considerable distance up this river, none of our party

succeeded in seeing a single one. Our native workmen had prepared themselves for this precious game, but in vain. Its meat brings in the Cartajena market twenty cents per pound. A few days before our return to the village of Sucio, one piece was killed at this place in the river, an occasion for a general holiday. Every bit of it was rapidly sold out, however, before we arrived. The only relic of it was a strip of the skin, twisted and dried to be used as a walking stick. According to this piece, the skin, when fresh, must have had nearly an inch thickness.

RUMINANTIA. CERVIDÆ.

Of this interesting, and for civilization particularly important family, only one specimen was seen by some few of the party. It was a deer inhabiting the more elevated regions on the Upper Truandó and Nercua. The color of the skin was described as reddish, the same as with our deer during the summer season. Whether this species may be identical with the Soche of the natives, Cervus columbianus, we are not prepared to say. The apparent scarcity of members of this family is in all probability in accordance with the general wild aquatic features of the greater portion of the Isthmus of Chocó.

MARSUPIATA. ENTOMOPHAGA.

Gen. Didelphys, L. D. sp? Opossum; Runcho; also Chucha de agua of the natives; Beutelratte of the German.

One specimen was obtained within the lowlands of the Truandó. Its external aspect made us suppose it to be nearly related to D. californica, the acquaintance of which I had made some time previous on the mouth of the Bravo del Norte.

Here closes our series of mammals, which were collected or noticed otherwise. However deficient this list appears to be, it exhibits some peculiarities, worthy to be mentioned. One is the singular combination by which types of the highest organization are thrown together almost exclusively with some species of lower orders, viz: the monkeys, with the manati, the sloth, and the opossum. Not less remarkable is the comparative scarcity of Ruminantia, an order so important for the sake of civilization. Gnawers and miners are pretty well represented, which is also the case with pachyderms. Generally, the destroying animals prevail, as if nature's creating activity in this latitude had had no other need but to check again, by every grade of animal life, her outpouring superabundance.

The zoölogical condition of the country is thus manifestly in accordance as well with its unorganic foundation, as also with the state of its vegetable developments, by which it is thickly covered.

As far as the topography and geology of the isthmus have been observed, it appears as if these regions, before the tertiary era, had undergone but few and less thorough geological changes than have been witnessed in other parts of our globe. It is perhaps for this reason that the fauna of the isthmus shows a large proportion of ani-

mals, the families of which possess pedigrees of highly antiquated nobility. These, in the instance of the sloth, date back even to the middle tertiary epoch, while that of the Didelphidæ recedes still further, going beyond the cretaceous, to the jurassic era.

The truly tropical members excepted, the fauna of the isthmus bears a marked neighborly relation to that of those countries which form the northern borders of the Gulf of Mexico. If we complete our series of mammals with those species, which, though not actually observed by us, are known beyond doubt to exist in the valley of Bas-Atrato, the following genera and species appear as belonging to both regions:

Felis, Sciurus, Dasypus, Dicotyles, Cervus, Didelphys. Two species are identical, as Felis concolor and F. onca. If F. pardalis does not occur here, it is at least very closely represented by what we believe to be F. tigrina. Of the other genera, nearly related species take the place of those which do not descend so far towards the equator.

XIII.

APPENDIX F.

ZOOLOGY—BIRDS.

BY JOHN CASSIN, OF PHILADELPHIA.

The subjoined catalogue of New Granadian birds, from the able pen of Mr. John Cassin, of Philadelphia, appeared in the last year's Proceedings of the Academy of Natural Sciences of Philadelphia, (see pages 132, 188, and 193,) and of which we propose to give here an exact copy, inserting only occasionally here and there brief notes, vernacular names, corrections, and references to the topography of the line of the survey. Mr. Cassin, in closing his introductory notes, says:

"This collection was made by Mr. William S. Wood, jr., and Mr. Charles J. Wood, of Philadelphia, who accompanied the expedition, and were, of course, under the immediate direction of the chief officer of the expedition, Lieutenant N. Michler, of the corps of United States topographical engineers. This accomplished officer and gentleman encouraged in the fullest degree investigations in natural history throughout the route, whenever consistent with other duties and as opportunity presented. To his enlightened views and evident appreciation of the interesting character of the zoölogy of the country traversed by the expedition science in America is indebted for the present valuable collection, including several birds never before known, and other valuable additions to the zoölogy of this continent."

In regard to this statement we have to add here that the organization of the party was somewhat more complicated, as will be seen in Lieutenant Michler's report on the organization of the expedition. The entire department of natural history, as zoölogy, botany, and geology, had been placed under my charge; and, in order to increase our opportunities, for the sake of science Lieutenant Michler detailed two sub-assistants for the duties of this department, under my orders. This selection fortunately fell upon the two brothers, Messrs. W. S. and Charles J. Wood, who both had been proposed to this position by Professor Sp. F. Baird, of the Smithsonian Institution. The untiring zeal with which these two sub-assistants fulfilled their engagements certainly deserves the most sincere acknowledgment, which to express gives us the more pleasure as they devoted their zeal and abilities not only to ornithology, but extended them also upon every other branch of zoölogy in general.

The entire omission of my name in Mr. Cassin's ornithological account, as well as the non-recognition of my labors connected with this department, while my name appeared upon almost every label of the collection, is of little consequence in itself; but as it deprives me even now of the opportunity to bring my field-notes in the proper connection with the respective species, it remains with me a matter of regret.

ARTHUR SCHOTT,
Naturalist and Geologist.

CATALOGUE OF BIRDS.

1. HYPOTRIORCHIS FEMORALIS, (Temminck.)
Falco femoralis, Temm. Pl. col. i, liv. 21.
Temm. Pl. col., 121, 343, U. S. Pacific R. R. Reports, X. pl. 1.

From Cartajena.

2. MORPHNAS GUIANENSIS, (Daudin ?)
Falco guianensis, Dand. Tr. d'Orm. ii, p. 78?
Lesson Traté d'Orm. ii, pl. 11?

From the Truandó; one specimen only; not adult, and in bad condition; appears to be this or a nearly allied species.

"Observed only once in the Truandó, at the first camp after leaving the Atrato. I noticed this eagle at first perched in a high tree, but after I had fired at a small bird he immediately flew very rapidly and fiercely directly towards the spot where I was standing, as though he intended to pounce upon me. He approached within a few feet, when I shot him with small bird shot." (C. J. Wood.)

3. ASTURINA MAGNIROSTRIS, (Gmelin.)
Falco magnirostris, Gm. Syst. Nat. i, p. 282, (1788.)
Temm. Pl. col. 86, Buff. Pl. Enl. 464.

From Turbo.

4. BUTEOGALLUS NIGRICOLIS, (Latham.)
Falco nigricolis, Lath. Ind. Orn. i, p. 35, (1790.)
Aquila milvoides, (Spix.?)
Spix. Av. Bras. i, pl. i, d? LeVaill. Ois. d'Afr. i, pl. 20.

From the Truandó. "Only observed in trees on the Truandó, about forty or fifty miles from the Cordilleras." (C. J. Wood.)

In the stomach of this species we found the remains of shrimps and other aquatic animals; this accounts for its preëminent aquatic habitat. (Schott.)

5. URUBITINGA MEXICANA, (Du Bus.)
Morphnus Mexicanus, Du Bus Bull. Acad., Brussels., 1857, p. 102.

From the delta of the Atrato. Specimens of this little-known species are quite identical with others from Mexico in the museum of this academy. It is accurately described by the viscount Du Bus, as above cited.

6. IBICTER AQUILINUS, (Gmelin.)
Falco aquilinus, Gm. Syst. Nat. i, p. 280, (1788.)
Buff. Pl. Enl. 417, Vieill. gal. i, pl. 6.

From Turbo, on the Atlantic, and the Truandó, near the Cordilleras. Abundant near the village of Turbó, but less numerous in the interior. Always seen in trees, and utters a very disagreeable note, bearing some resemblance to the gobble of the male turkey. (C. J. Wood.)

The Indians call this bird Taun-taun, and maintain that it lives on wasps and bees. Our negro laborers called it Bruja. The species seems to be quite common and well known. The majority of our specimens were obtained from the low and table lands along the Truandó and Nercua river. I found them most noisy a few hours before noon and towards sundown. (Schott.)

7. NYCTIDROMUS GUIANENSIS, (Gmelin.)
Caprimulgus guianensis, Gm. Syst. Nat. ii, p. 1030.
Caprimulgus albicollis, Lath. Ind. Orn. ii, p. 585, (1790.)
Buff. Pl. Enl., 733.

From Turbó. Smaller than N. Americanus, but much resembling that species.

8. PROGNE CHALYBEA, (Gmelin?)
Hirundo chalybea, Gm. Syst. Nat. i, p. 1026, (1788?)

Young birds from Cartajena; very difficult to recognize, but much resembling the species I understand to be as here given.

9. COTYLE FLAVIGASTRA, (Vieillot.)
Hirundo flavigastra, Vieill. Nouv. Dict. xiv, p. 534, (1817.)
Hirundo jugularis, DeWied.
Temm. Pl. Col. 161, fig. 2.

From Cartajena and the Truandó.

10. CERYLE TORQUATA, (Linnæus.)
Alcedo torquata, Linn. Syst. Nat. i. p. 180, (1766.)
Buff. Pl. Enl. 284.

From the Atrato and Truandó. Numerous specimens in the collection, which are exclusively adults in fine plumage.

"Very abundant in the immense swamps on the Atrato and Truandó, alighting on the low trees and uttering a loud, shrill note. Catches small fishes apparently very easily, on account of their abundance, and returns to the tree." (C. J. Wood.) In dissecting one of the species, a large number of "Filaria" was found along the

spine. These are now preserved in alcohol and deposited in the Smithsonian Institution. (Schott.)

11. Ceryle Amazona, (Latham.)
Alcedo Amazona, Lath. Ind. Orn. i. p. 257, (1799.)
Alcedo vestita, Dumont.
Du Bois, Orn. Gal. pl. 85.

From the river Nercua. We thought to observe a certain analogy between the decreasing dimensions of the rivers and the size of the members of this genus, though the smallest could be seen all along the line. (Schott.)

12. Ceryle Inda, (Linnæus.)
Alcedo Inda, Linn. Syst. Nat. i. p. 179, (1766.)
Alcedo viridirufa, Bodd. Tab. Pl. Enl. p. 36, (1783.)
Alcedo bicolor, Im. Syst. Nat. i. p. 451, (1788.)
Edwards Glean. vii. pl. 355, Buff. Pl. Enl. 592.

From Turbo. Common enough in South American collections, but never quite correctly named in catalogues, or hardly elsewhere. Naturalists evidently overlook the solemn fact that Linnæus gives the habitat of this species as above cited, "in India occidentali!" The name India seems to have been understood to mean a far distant country, beyond the Ganges, and evidently misled even Boddært and Gmelin, but is strictly applicable to this bird. It can readily be recognized from the description and Edwards's figure above cited. "One specimen seen in a salt water marsh near Turbo, very quiet and easily approached." (C. J. Wood.)

13. Ceryle superciliosa, (Linnæus.)
Alcedo superciliosa, Linn. Syst. Nat. i. p. 179, (1766.)
Edwards Glean. v. p. 245, Buff. Pl. Enl. 756, fig. 213.

From Turbo. "In a salt water marsh, almost in the village of Turbo, one specimen only seen perched in a bush, which was obtained without difficulty, being very unsuspicious." (C. J. Wood.)

14. Jacamerops grandis, (Gmelin.)
Alcedo grandis, Gm. Syst Nat. i. p. 458, (1766.)
Le Vaill. Jacamaras, pl. 54.

From the Truandó. "First camp after leaving the Atrato, and the only time that this bird was noticed. Sits in a tree and darts after insects like a fly-catcher." (C. J. Wood.) The same species was observed by me in the woods about Cartajena, sitting in the attitude as Mr. W. states. This bird, together with its congeners, is known to the natives under the names Tucucito, Tornasol, Tornasolito, on account of its beautiful resplendent plumage. (Schott.)

15. Galbula ruficauda, (Cuvier.)
Galbula ruficauda, Cuv. Reg. An. i. p. 420, (1817.)
Le Vaill. Gacr. pl. 50, Visill. Gal. 1, pl. 29.

From the river Nercua. One specimen only in bad condition, which appears to be this species, but is darker chestnut brown on the abdomen than other specimens now before me.

16. BUCCO RUFICOLLIS, (Lichstentein.)
Bucco ruficollis, Licht. Wagler, Isis, 1829, p. 6158.
Tamatia bicincta. Gould. Proc. Zoöl. Soc. Lond. 1836, p. 80 ?
Tamatia gularis, D'Orb. et. Lafres. Rev. Zoöl. 1838, p. 166?

From the Truandó. "Seen once only at the first camp on the Truando after leaving the Atrato." (C. J. Wood.)

For all that I can see, this is the young of B. bicincta, Gould, as above, with which B. gularis, D'Orb. appears to be synonymous.

17. MALACOPTILA PANAMENSIS, (Lafresnaye.)
Malacoptila Panamensis, Lafres. Rev. Zoöl. 1847.

From the Truandó. "Very quiet and inactive, starting out occasionally from its perch to capture an insect, and then returning." (C. J. Wood.)

18. MONASA PALLESCENS, (nobis.)

Rather larger than any other known species; wing rather long, fifth quill longest; tail moderate, with the feathers wide. Front and lores white, entire head quills, upper and under tail coverts black, with a greenish luster, (no white on the chin or throat,) upper and under wing coverts, back, rump, and under parts of body cinereous; very light on the upper wing coverts, and darker on the back; bill red, sexes alike.

Total length about eleven inches, wing 5.5, tail five inches. Hab. Cordilleras mountains on the Truandó, New Granada. In National Museum and Mus. Acad. Philad., discovered by Messrs. Ch. J. and .Wm. S. Wood, jr.

This is a remarkable and apparently new species of Monasa, strictly of the same group, and related to M. Morphocus (albifrous and personata) and M. peruana. Like those species, the present bird has a conspicuous white frontal band, which reaches very nearly from one eye to the other, but it differs from those species in being without any white whatever on the throat. It is, however, easily distinguished from all known species by the cinereous color of the body above and below, and wing coverts, which color is very light, and in some specimens nearly white, on the whole, and but slightly darker on the under wing coverts. Several specimens, labeled as both sexes, are in the collection from the Truandó. Stated by Messrs. W. S. and C. J. Wood to have been seen once only in the Cordilleras on the river Truandó, in January, 1858. A party of eight or ten specimens were observed sitting very quietly in a tree at some distance from the ground, and, being quite regardless of the gun or presence of man, several were obtained. Specimens labeled as females are slightly larger than those stated to be males.

19. TROGON MASSENA, (Gould.)
Trogan Massena, Gould; Monog. Trogonidæ, (1838.)
Gould, Mon. Trogon, pl. 16.

From the Truando and also the Atrato delta. All the specimens in the collection are of young birds in but indifferent condition, amongst which one specimen may be the young of T. macrourus.

T. massena has been various times observed on the Atrato while the party were ascending this river. It seems to be much more common throughout than its congeners. In skinning it we observed that the fat of the bird somewhat partakes of the color of the plumage; thus it is under the scarlet feathers on the abdomen of a rich orange. The plumage is with all the Trogons exceedingly deciduous. (Schott.)

20. TROGON MELANOPTERUS, (Swainson.)
Trogon melanopterus, Sw. lub. Cy. p. 332, (1838.)
Gould, Mon. pl. 10, 11.

From the Truandó. One specimen only in adult plumage.

21. TROGON ATRICOLLIS, (Vicillot.)
Trogon atricollis, Vicill. Nouv. Dict. viii, p. 318, (1817.)
Gould, Mon. pl. 8.

Falls of the Truandó. "In the Cordilleras on the Truando; seen once only; very unsuspicious, and easily shot." (C. J. Wood.)

This Trogon is called by the natives El Lindo—a very appropriate name, on account of its beautiful plumage; for this reason, however, it may apply to most of the members of the genus. (Schott.)

22. MOMOTUS MARTII, (Spix.)
Prionites Martii, Spix. Av. Bras. i, p. 64, (1824.)
Momotus semirufus, Sclater; Rev. A. Maj. Zoōl., 1833, p. 489?
Spix. Av. Bras. i, pl. 60.

From the river Nercua. One specimen in adult plumage, labeled as a male bird.

23. CRYPTICUS PLATYRHYNCHUS, (Leadbeater.)
Momotus platyrhynchus, Leadb. Trans. Linn. Soc. London, xvi, p. 92, (1829.)
Crypticus Martii, Bonap. Proc. Zoöl. Soc. Lond., 1837, p. 119.
Gard. and Selby, Ill. Orn. iii, pl. 106.

From the Cordilleras on the river Nercua. In adult plumage, and in colors singularly resembling the preceding, but with the bill differently formed and affording strong generic distinctions. This is probably the first time that these two birds, which have much perplexed naturalists, have ever occurred in the same collection. Both are labeled as from the same locality, and I am informed by Mr. C. J. Wood that they inhabit the forests on the river Nercua on the western side of the Cordilleras.

Mr. C. J. Wood at the time remained stationed behind at the observatory near the Truandó falls. He himself never saw the Nercua, which is an Atlantic stream, washing the eastern side of the Cordilleras. This bird, therefore, belongs also to the eastern side. In general, all the species of Momotus, as well as those of the Galbula and allied genera, are only sporadic forms of the fauna of Chocó; according to our observations they inhabit no special section of the country. (Schott.)

25. Rhamphastos Tocardus, (Vicillot.)
Rhamphastos Tocard. Vieill. Nouv. Dict. xxxiv, p. 280.
Rhamphastos Swainsonii, Gould; Proc. Zoöl. Soc. Lond., 1833, p. 69.
Gould, Mon. Rhamph., pl. 4.

From the river Nercua.

26. Rhamphastos carinatus, (Swainson.)
Rhamphastos carinatus, Sw. Zool. Ill. i. p. (pl. 45 not paged.)
Gould, Monog. pl. 2.

River Nercua. One specimen only in mature plumage from the western (?) side of the Cordilleras on the Nercua.

27. Pteroglossus erythropygius, (Gould.)
Pteroglossus erythropygius, Gould, Proc. Zoöl. Soc. Lond. 1843, p. 15.
Gould, Monog. pl. 21, Zoöl. Voy. Sulphur; pl. 28.

From the Truandó specimens labeled as both sexes are in the collection. The females are smaller, and in both sexes there is some variation in the color of the bill as noticed by Mr. Gould, the white being in these specimens more extended in the females.

In the stomach of several of the specimens of this species the globular fruits of a large tree, a species of Ficus, were found mixed up with particles of animal food, which latter probably belonged to some species of the class of Articulata. All the Toucans were found of very quiet habits, shifting in small parties about, and invariably mounting the tops of the highest trees. The natives call them Dios te de, or Dios te ve, which Spanish phrase closely expresses their peculiar dactylic note which we sometimes heard towards sundown. Other names are Coli amarillo, and Dos dares. Our Cartajena negroes called them Paltó. In the latter place birds of this species are brought to market as pets, (Schott.)

28. Selenidera spectabilis, (Cassin.)
Jour. Acad. Phila. iv. pl. 1.
Selenidera spectabilis, Cass. Proc. Acad. Phila. 1857, p. 214.

From the falls of the Truandó. Both sexes of this species, in excellent plumage and preservation, are in the collection from the Cordilleras on the Truandó. They are, however, precisely similar to Mr. Mitchell's specimens described by me as above cited, though the oc-

currence of this little known species again and at another locality is a point of interest.

29. ARA MILITARIS, (Linnæus.)
Psittacus militaris, Linn. Syst. Nat. i. p. 139, 1766.
Le Vaill. Parrots. pl. 6; Edwards Glean. vii pl. 313.

From the river Nercua in the Cordilleras mountains.

30. ARA ARARAUNA, (Linnæus.)
Psittacus ararauna, Linn. Syst. Nat. i. p. 139, 1766.
Le Vaill. Parrotts. pl. 3; Lear. Parr. pl. 8.

From the mouth of Atrato, Gulf of Urabá. This was found to be the most common species, having seemingly the widest range along the line. We saw it tamed at Cartajena and also on the Pacific side of the divide. The natives call it guacamayo and guacamaya. We miss in this catalogue a third form of the larger Macaws, of which one specimen was secured at Turbo. It was registered there with the collection No. 301. The species seemed to me to be Ara macao, or Psitticus macao, and is the same which daily in numberless groups cross during the forenoon the Gulf of Urabá to follow its sport in the Atrato delta, whence it recrosses again in the evening, retiring to its roosting place in the hill slopes back of Turbo. This makes for the bird a regular journey of at least twenty miles per day. (Schott.)

31. ARA SEVERA, (Linnæus.)
Psittacus severus, Linn. Syst. Nat. 1. p. 140, 1766.
Le Vaill. Parr. pl. 8, 9, 16, Edwards Glean. v. pl. 219.

Mouth of the river Nercua.

32. CONURUS PERTINAX, (Linnæus.)
Psitticus pertinax, Linn. Syst. Nat. i. p. 142, 1766.
Le Vaill. Parr. pl. 34, Edw. Glean. v. pl. 234.

Cartajena. Very common there, and in great numbers sold to strangers. This bird seems scarcely to stand a change to higher latitudes. Some two dozen of the species were shipped by our homeward-bound party, but on passing the West India Islands mortality commenced among them. The majority died before reaching Cape Hatteras; very few reached Washington, where they also soon died. The symptoms of their disease were very uniformly repeated fits until death ensued. (Schott.)

33. CONURUS TOVI, (Gmelin.)
Psittacus Tovi. Gm. Syst. Nat. i. p. 351, (1788.)
Bourj. St. Hil. Par. pl. 48.

From the river Atrato. For this species the negroes of Cartajena give the vernacular name Cheja, which seems to express the sharp, disagreeable note of the bird.

34. Psittacula cyanoptera, (Boddaert.)
Psittacus cyanopterus, Bodd. Tab. pl. enl. p. 27, 1783.
Psittaculus gregarius, Spix. Av. Bras. i. p. 39, 1824.
Bourj. St. Hil. Parr. pl. Spix. Av. Bras. i. pl. 34.

Cartajena. Another very small species of Psittacus was obtained on the banks of the Atrato, which we are not able to recognize in this enumeration. We had registered No. 81 Parakeet, Atrato, and was marked as (♀) female. The size was that of a finch. (Schott.)

35. Dryocopus Malherbie, (J. R. Gray.)
Campephilus Malherbei, J. R. Gray, Gen. Birds ii. p. 436, pl. 108, 1845.
Malherbe, Monog. Picidæ, pl. 6.

From Turbo. Occasionally seen in the forest at Turbo; very shy and difficult to approach. (C. J. Wood.)

36. Dryocopus albirostris, (Vieillot.)
Picus albirostris, Vieill. Nouv. Dict. xxvi. p. 69, (1818.)
Megapicus albirostris, (Vieill.) Malherbe.
Malherbe, Monog. Picidæ. pl. 4.

37. Celeus mentalis, (Nobis.)

About the size of C. rufus; occipital feathers somewhat lengthened; third quill longest; bill rather short; male with a large space on the chin and throat, bright scarlet. This space begins nearly on a line with the commissure of the bill on each side, covering the chin and throat, and is not divided in the middle, but is integral. Head and upper parts of body dark cinnamon, many feathers having semicircular and crescent-shaped spots of black; rump and upper tail coverts brighter; quills brownish black barred with dark cinnamon; tail brownish black, all the feathers of which are barred with a dull, yellowish cinnamon color; under parts of body yellowish cinnamon, lighter than the black, and with the black spots much more numerous, every feather having nearly complete semicircular and cresent-shaped bands of black; under wing coverts uniform dark cinnamon, not spotted; axillaries dark cinnamon, with a few imperfect bands of deep black; bill bluish horn color; under mandible lighter. Female much like the male, but having no red patch on the throat, and the black spots on the under parts not so numerous. Total length about 8 inches; wing, 4¾; tail 1¾ inch.

Hab. Turbo and Atrato river. Discovered by Messrs. Wm. S. and C. J. Wood; Spec. in Nat. Mus. Washington.

Of this woodpecker I have found no description or figure which seemed to approach it, except Picus undatus of authors figured by Edwards, pl. 332. It is nearly the size and of the same general colors as that species; but, instead of two patches of red on the cheeks as described and figured in P. undatus, the present bird has a single large patch completely inclosing a space on the throat around the base of the lower mandible, similar to that in the common Picus varius of the

United States. This character I cannot trace in any other species of this genus.

This bird belongs to the same subgeneric group as Celeus rufus, which seems to have no name, though readily defined.

37. CROTOPHAGA MAJOR, (Brisson.)
Crotophaga major, Brisson, iv, p. 180, 1760. Buff pl. enl. 102.

From the river Atrato; vernacular name is Chamon. (Schott.)

38. CYANOCORAX PILEATUS, (Temmink.)
Corvus pileatus, (Temm.) pl. col. (Liv. 10.) Lemm. pl. col. 58.

From the Truandó and Nercua.

"In flocks on high trees on the Truandó before reaching the mountains. Very shy and noisy, calling out loudly whenever an attempt was made to approach them." (C. J. Wood.)

39. OUISCALUS MACROURUS, (Swainson.)
Ouiscalus macrourus, Sw. Cab. Cy., p. 199, 1838.
Rept. U. S. and Mex. Bound. Survey, Birds, pl. 30.

"From Turbo and Cartajena; in parties of ten or a dozen, feeding on berries along the sea-shore. Abundant, especially along the sea-shore, and noisy, but not easily shot." (C. J. Wood.)

40. OCYALUS WAGLERI, (J. R. Gray.)
Cacicus Wagleri, J. R. Gray Gen. Birds, ii, p. 342, 1845.
Gray's Genera, ii, pl. 95.

From the rivers Truandó and Nercua. Specimens of both sexes in mature plumage, the females being much the smaller.

41. OSTINOPS CRISTATUS, (Gmelin.)
Oriolus cristatus, Gm. Syst. Nat. i, p. 387, 1788.
Sw. B. of Bas., pl. 32. Buff. pl. enl. 328.

From Turbo and the Atrato.

"In company with smaller species along the Atrato, and seemed to be feeding on the fruit of a tree which grew plentifully on the edge of the water. Unsuspicious, and easily approached." (C. J. Wood.)

•42. OSTINOPS GUATIMOZINUS, (Bonaparte.)

Ostinops Guatimozinus, Bonap. Comple. Read. 1853, p. 833. Large, resembling O. Montezumæ and O. Bifasciatus, but larger than either; darker colored, and with the crest feathers much longer and more slender. Male—head, under parts of the body, and tibiæ, brownish black; under tail coverts chestnut brown, same as the back; entire upper parts of body, wing coverts, and outer webs of quills, purplish chestnut brown; tail graduated; the eye completely divided by a line of short, imbricated feathers, nearly on a line with the lower edge of the lower mandible; crest long, and composed of very narrow feathers; bill wide at base in front, high, and completely pointed; basal, two

thirds black; terminal—one third light colored, (red?) Total length, about 21.5 inches; wing, 10.5; tail, 8.5 inches; crest feathers, 3 inches; bill, from gape, 2.25 inches. Hab., river Truandó.

One specimen, labeled as a male in the collection, is distinct from any spec. in Arad. coll., or that we found described, except as above. It is nearly allied to O. Montezumæ of Mexico and Central America, and O. bifasciatus of Northern Brazil, both of which are in the academy collection, and are distinct from each other.

"The present bird differs from both the above species in being larger, darker colored, and having a lengthened, almost filiform, crest. The bill also is disproportionately longer, and wider at the base, with a rounded termination in front. It is not without scruples that I apply the above name to this bird, the description by the Prince Bonaparte, as cited, not being sufficient for the recognition of any species not nearly related to another. At Camp Abert, on the Truandó, before reaching the Cordilleras, one specimen only was seen, which was shot. It was very shy, and seemed to be a stranger." (C. J. Wood.)

In regard to Mr. Cassin's description, I can ascertain that the terminal one third of the bird's bill was bright red, which faded in drying, probably by the effects of the arsenic.

This bird, like its congeners and allied forms, are well known to the natives, and stand in bad reputation as the most cunning and voracious banana and plantain thieves. They are also rather badly complimented by their vernacular names, as Rabo hediondo, Cola hediondo, and also babilla; the former meaning skunk tail, which part they do not seem to keep very clean. These birds live somewhat gregarious, building their nests, often thirty or forty in number, on the tallest trees to be found. These they suspend on the outermost branches, so as to secure themselves against their enemies, especially arboreal snakes. The form of the nests is curious. The lower and main portion is about ten and fifteen inches, with a long, very slender neck, by the end of which it is fastened to the tree. The entrance is between the neck and the main portion. We often observed certain trees along the Truandó curiously adorned with the nursery pouches of this musophagous population.

The genus seems to partake somewhat in the habits of other "blackbirds," by which they make clear generic distinctions somewhat difficult, injuring the purity of their pedigree.

Camp Abert, not being a surveying station, does not appear on the maps of the expedition. It is situated within the lowlands, where the Truandó begins to form sandy depositories. (Schott.)

43. Cassicus icteronotus, (Vieillot.)
Cassicus icteronotus, Vieill. Sw. B. of Braz., pl. 3.

From Turbo and the delta of the Atrato; very abundant at Turbo. Builds many nests on the same tree, which are long and hanging, and entered at the top. Always seen in large parties, and very noisy, especially in the morning, although their notes are rather agreeable. (C. J. Wood.)

The note of this bird somewhat resembles that of the Auiscalus macrourus, from the Rio Bravo del Norte. The nest of the bird is also pendulous, but is not furnished with the long neck of the former. These birds also build in numbers together, suspending their little homes on slender mangrove branches, not easily accessible to their enemies. (Schott.)

44. CASSICUS CHRYSONOTUS, (Lafresnaye.)
Cassicus chrysonotus, Lafresn. D'Orb. Voy. Am. Mer. Ois., pl. 52?

From Turbo; a single specimen in young plumage appears to be this species.

45. CASSICUS UROPYGIALIS, (Lafresnaye?)
Cassicus uropygialis, Lafr. Bev. Zoöl, 1843, p. 290?

Falls of the Truandó. Specimens not mature, or in good condition, appear to be this species.

46. ICTERUS MESOMELAS, (Wagler.)
Icterus mesomelas, Wagl. Lesson, Cent. Zoöl., pl. 22.

From the Atrato.

47. ICTERUS GIRAUDII, (Cassin.)
Icterus giraudii, Cass. Proc. Acad., Philad. iii, p. 332, (1847.) Jour. Acad., Philad., i, pl. 47.

From the Truandó and Nercua and the shores of the Pacific.

Several species, differing somewhat in size, are from the Cordilleras and the western coast, until quite reaching the Pacific ocean. The specimen obtained by W. S. Wood, is labeled "shores of the Pacific."

"In bushes and low trees on the Truandó, and has very pleasant notes, of the same general character of the Baltimore Oriole; solitary and rather wild." (C. J. Wood.)

The specimen from the Pacific side was registered in the collection under No. 199. (Schott.)

48. XANTHORNUS AFFINIS, (Lawrence.)
Xanthornus affinis, Lawr. Amer. Lyc., New York, 1851, p. 113.

From the Atrato. A single specimen, in adult male plumage.

49. EUSPIZA AMERICANA, (Imelin.)
Emberiza Americana, Im. Syst. Nat., i, p. 872, 1788.
Wilson's Amer. Orn., i, pl. 3; Aud. B. of Am., p. 384, oct. ed., iii, pl. 156.

From Turbo. "In flocks early in April, about grassy places, a Turbo, and seen for one day only." (C. J. Wood.)

On April 1 the whole party had returned to Cartajena; thus Mr. Wood's date is anticipated. (Schott.)

50. Pitylus Grossus, (Linnæus.)
Loxia Grossa, Lin. Syst. Nat., i, p. 307, (1766.) Buff., pl. enl. 154.

"From the Falls of the Truandó, in the mountains; seen only once. Has a loud, musical note, similar to that of the cardinal bird of the United States." (C. J. Wood.)

51. Saltator mutus, (Sclater?)
Saltator mutus, Sclater, Proc. Zoöl. Soc., London, 1856, p. 72?
Tanagra superciliaris, Spix, Av. Braz., ii, p. 44, pl. 47?

From Cartajena, on the Popa mountain. Specimens in young plumage; not, for us, easily identified.

52. Arremon Schlegeli, (Bonaparte.)
Arremon Schlegelii, Bonap. Consp. Av., i, p. 488, 1850.

From Cartajena. Very fine specimens of this beautiful little bird in adult plumage.

"In the high grass on the sea-shore, at Cartajena, on the seed of which it appears to feed. Notes and habits generally appeared to resemble those of the sparrows of the United States; not abundant, and difficult to obtain." (C. J. Wood.)

53. Pyranga æstiva, (Imelin.)
Tanagra æstiva, Im. Syst. Nat., i, p. 889, 1788.
Wilson's Am. Orn., i, pl. 6; Aud. B. of Am., pl. 44, oct. ed., iii, pl. 208.

From Turbo. In the forests in Turbo, early in April? seen once only.

54. Orthogonis Olivaceus, (Nobis.)

Form short and robust; bill rather wide at base; upper mandible with a distinct tooth-like lobe about the middle of its cutting edge; wing moderate, fourth quill slightly longest; tail moderate, or rather short. Male: front, and line extending over and around the eye, bright yellow; throat, middle of abdomen, edge of wing at shoulders, and under wing coverts, greenish yellow; upper parts of head and body dark olive green, tinged with yellow, the latter color more apparent in the middle; under tail coverts greenish yellow; quills brownish black, with the outer webs dark olive, uniform with the back; tail dark olive; inner webs of outer feathers greenish brown; the yellow on the throat somewhat striped or spotted with dark olive; bill bluish horn color; legs brighter; sexes similar. Total length about 6¾ inches; wing 3½, tail 2½ inches. Hab. Cordilleras mountains, on the Tuandó; discovered by Messrs. W. S. and C. J. Wood, attached to the United States expedition for surveying an interoceanic ship canal route via the Atrato and Truandó, in command of Lieut. N. Michler, United

States topographical engineers. Specimen in National Museum, Washington.

This is a curious bird, and has not a little puzzled the present writer. My impression is that it is an undescribed genus related to Icteria, and more so to Octhogonys, and not unlike to some species of Ryranga. At present, I rate it as an Orthogonys, to which it quite as much belongs as Pyranga cyanictera of authors, at least, of which there are several specimens in the academy collections.

Mr. C. J. Wood states that this bird inhabits low trees and bushes in the Cordilleras, on the Truandó, and could be constantly heard at some localities, though not easily seen. Its notes are loud, and much varied, bearing a general resemblance to those of the Chat, of North America, (Icteria viridis.) It appeared to be very active and lively, constantly flying about the bushes and changing its position.

55. TANAGRA CANA, (Swainson.)
Tanagra cana, Sw. B. of Br., p. 2, 1841.
Sw. B. of Braz., pl. 37.

From Turbo.

"Abundant in the lime and orange trees at Turbo, and in gardens and other cultivated localities at Cartajena. Note, only a single chirp, and very unsuspicious and easily shot." (C. J. Wood.)

56. RHAMPHOCELUS ICTERONOTUS, (Bonaparte.)
Rhamphocelus Icteronotus, Bonap. Proc. Zoöl. Soc., Lond., 1836, p. 121.
Du Bus, Esq., Orn., pl. 15.

From Turbo and the rivers Atrato and Truandó.

"Always observed frequenting one kind of tree that grows along streams of water, on the fruit of which it feeds. Abundant on the Truandó in the month of March." (C. J. Wood.)

Mr. Wood seems to be mistaken here about the time of his observations. Himself, with the party not immediately connected with the actual survey, had returned to the gulf of Urabá on the 26th February. (Schott.)

57. RHAMPHOCELUS DIMIDIATUS, (Lafresnaye.)
Rhamphocelus dimidiatus, Lafresn. Mag. Zoöl., 1837, not paged.
Guernis, Mag. Zoöl., 1837, p. 81.

From Turbo.

"Abundant in April in the bushes and low trees in the drier parts of the forest. Solitary but constantly seen, and heard only to utter a single chirp." (C. J. Wood.)

The date here is also anticipated, for the whole of the expedition arrived in the Cartajena harbor on the 1st of April. (Schott.)

58. ENCOMETIS CRISTATA, (Du Bus.)
Pipilopsis cristata, Du Bus, Butt. Acad. Bussels, 1855, p. 184.

From the Truandó.

"From the first camp on the Truandó leaving the Atrato; in the bushes and low trees, very shy, and seen only in a party of three together; sings very pleasantly and very loud for the size of the bird." (C. J. Wood.)

59. TACHYPHONUS LUCTUOSUS, (D'Orb et Lafres.)
Tachyphonus luctuosus, D'Orb et Lafres. Mag. Zoöl., 1837, p. 29.
D'Orb, Voy, Am. Mev. Ois., pl. 20.

From the Truandó.

"Obtained during our encampment in the mountains on the Truandó; in the high trees and rarely seen, and very shy and active; male black; female brown." (C. J. Wood.)

60. TACHYPHONUS DE LATTREI, (Lafresnaye.)
Tachyphonus de Lattrei, Lafres. Rev. Zoöl., 1847, p. 72.

Falls of the Truandó.

"Seen once only in the bushes on the bank of the Truandó, in the month of March?? About twenty specimens which seemed to be in company were noticed, and several obtained, though they were very shy and not easily approached. All chattered together like a flock of blackbirds, and appeared to feed on a berry that was abundant." (C. J. Wood.)

61. TACHYPHONUS XANTHOPYGIUS, (Sclater.)
Tachyphonus xanthopygius, Sclater, Proc. Zoöl. Soc., London, 1854, p. 158.
Proc. Zoöl. Soc., London, 1854, pl. 69; 1855, pl. 90.

From the Truandó.

The male only of this handsome and remarkable species precisely as figured by Mr. Sclater.

"The wildest bird I met with in the whole journey. A portion of the surveying party remained fifteen days at a camp in the Cordilleras on the Truandó, where only this bird was obtained, and was so very shy and watchful that it was with difficulty obtained. Three specimens were together, and observed to always resort to one tree to roost, and constantly frequenting the highest trees; very active, and perpetually on the move from one tree to another; notes loud and musical, somewhat like those of the Baltimore oriole of the United States." (C. J. Wood.)

62. TACHYPHONUS?

Falls of the Truandó.

One specimen labeled as a female, but which is of no species with which I am acquainted or find described; not having the male, I do not venture a description.

63. CALLISTE FRANCESCÆ, (Lafresnaye.)
Aglaia Fanny, Lafres. Rev. Zoöl., 1847, p. 72.
De Murs Icon. Orn. pl. 56.

From Turbo.

"In a tree that grows along streams of water, on the seeds of which it feeds; rather shy and not easily approached; very quick and active." (C. J. Wood.)

64. CALLISTE INORNATA, (Gould.)
Calliste inornata, Gould, Proc. Zoöl. Soc., London, 1855, p. 158.
Sclater, Monog. calliste, pl. 45.

From Turbo.

Probably the female or young of the preceding, (C. Francesæ.) and given by us as distinct with some reluctance. The specimens in the collection are very nearly as described and figured as cited above.

"In the same tree, and appeared to be in company with the preceding, and thought by my brother and myself to be the female of that bird." (C. J. Wood.)

65. CALLISTE LAVINIÆ, (Cassin.)
Calliste Laviniæ, Cass. Proc. Acad., Philadelphia, 1858, p. 178.

From the Truandó.

"We have much gratification in finding in the present collection the second specimen that we have ever seen of this interesting little species, though not in mature plumage. It bears, however, the characteristic edging of rufous on the outer webs of the quills, and is easily recognized; shot at Camp Toucey in the mountains on the Truando; in high trees, very active and lively, and not easily obtained, though not often seen; March ??" (C. J. Wood.)

Camp Toucey, one of Lieutenant Craven's traveling stations, is situated in the dark swamps of a region called by the natives Las Palizadas, on account of the fallen timber which here obstructs the course of the river, dividing it into a great number of branches and sloughs. On the map the place is called Camp En las Palizadas. There are certainly no mountains in that vicinity, the elevation of which is only a few feet above the overflow of the Atrato. It was on the 18th of February when Mr. Wood and the whole of the surveying party passed this place on our return home; consequently his dating March is an anticipation. (Schott.)

66. EUPHONIA FULVICRISSA, (Sclater.)
Euphonia fulvicrissa, Sclater Proc. Zoöl. Soc., Phil., 1856, p. 276.

Falls of the Truandó.

"At our encampment in the mountains on the Truandó in high trees, and difficult to shoot. Not often seen, and shy and watchful. (C. J. Wood.)

67. NEMASIA AURICOLLIS, (Sclater.)
Nemasia auricollis, Sclater Proc. Zoöl. Soc., Lond., 1856, p. iii.

From the Truandó.

"At the first camp on the Truandó before reaching the mountains;

in the bushes growing abundantly in the extensive marshes and swamps on that river. Appeared to have habits much like those of the wrens, and constantly repeated its notes, so as to be easily followed." (C. J. Wood.

68. LIPANGUS UNIRUFUS, (Sclater.)
Lipangus unirufus, Sclat. Proc. Zoöl. Soc., London, 1859, p. 385; Querula fuscocinerea, Lefres. Zoöl., 1843, p. 291?

From Turbo and the Truandó. Entire plumage light rufous; darker on the back, and lighter on the under parts of the body and under wing coverts; quills and tail, rufous cinnamon; shafts and inner webs of quils, darker. Total length, about 9 inches; wing, 5; tail, 4½ inches. Sexes alike. Several specimens, labeled as both sexes, are from Turbo and the river Truandó, and all have the appearance of being in young, or some peculiar seasonal plumage. These specimens are all of an uniform dull rufous, very near the color of the immature plumage in some species of black Tachyphonus, which induces me to suppose that the adult of this bird is quite different in color from the present specimens. Although undoubtedly of the genus Lipangus, this bird corresponds but indifferently with the description last cited, though it may be that species in the plumage of another seoson than that described.

"In the dry parts of the forests of Turbo, and in the Cordilleras of the Truandó, in the lower trees. Frequently seen, but always solitary and silent. Sits very quiet in a tree, and flies after insects, especially the large coleopterous species abundant on the route everywhere." (C. J. Wood))

69. QUERULA CRUENTA, (Boddaert.)
Muscicapa cruenta, Bodd. Tab. pl. nel., p. 23, 1783.
Buff. pl. enl. 381; Vicill. Gall., pl. 115.

From Turbo.

"Very abundant, and in large parties in the thick and dry parts of the forests of Turbo. Constantly chattering and noisy. Frequently seen on the ground, and seemed to prefer low bushes. Female entirely black." (C. J. Wood.)

70. SOROPHAGUS LICTOR, (Lichtenstein.)
Lanius Lichtor, Licht. Verz., p. 49, 1823.
Gray, Genera of B., i, pl. 62.

From the rivers Atrato and Truandó.

71. TYRANNUS DOMINICENCIS, (Brisson.)
Tyrannus dominicencis, Briss. Orn., ii, p. 394, 1760.
Aud. B. of Am., pl. 46, oct. ed., i, pl. 55.

From Cartajena.

72. Tyrannus melancholicus, (Vieill.)
Tyrannus melancholicus, Vieill. Neuv. Dict., xxxv, p. 48, (1819.)
Spix. Av. Braz., ii, pl. 19.

From Turbo, Cartajena, and the Truandó.

73. Myiacorax ferox, (Gmelin.)
Muscicapa ferox, Gm. Syst. Nat., i, p. 394, 1788.
Buff. pl. enl., 571, fig. 1.

Falls of the Truandó.

74. Elænia Cayennensis, (Linnæus.)
Muscicapa cayennensis, Linn. Syst. Nat., i, p. 327, 1766.
Buff. pl. enl., 569, fig. 2.

From Turbo.

75. Sayornis ardosiacus, (Lafresnaye.)
Tyrannula ardosiacus, Lafresn. Rev. Zoöl., 1844, p. 80.

Falls of the Truandó.

"A pair observed about rocks at the foot of the mountains on the Truandó. Had some very pleasing notes, and an almost continuous song. Very shy." (C. J. Wood..)

76. Myiobius Sulphureipygius, (Sclater.)
Tyrannula sulphureipygia, Sclat., Proc. Zoöl. Soc., London, 1856, p. 296.

From the Truandó.

77. Tyraunnula albiceps, (D'Orb et Lafresnaye.)
Musipeta albiceps, D'Orb et Lafresn., Magaz. Zoöl., 1837, p. 47.

From Cartajena.

78. Tyrannula albiceps?

Apparently an accidental variety of the preceding, having the back light yellow, or canary color. One specimen from Cartajena.

79. Cyclorhynchus brevirostris, (Cabanis.)

Cyclorhynchus brevirostris, Cab. Wiegm. Arch., 1847, p. 249.
From the Truandó.

80. Platyhynchus Cancroma, (Lichtenstein.)
Lodus cancroma, Licht. Verz. p. 51, 1823.
Temm. fil. col. 12, fig. 2. Sn. Zoöl. Ill. ii. pl. 115.

From the Truandó.

"From the Palisades, on the Truandó, soon after leaving the Atrato. In the high trees and difficult to obtain." (C. J. Wood.)

81. TODIROSTRUM CINEREUM, (Linnæus.)
Todus cinereus, Linn. Syst. Nat. i. pl. 178, 1766.
Ruff. pl. enl. 585, fig. 3.

From Cartajena.

"Occasionally seen on the Popa Mountains near Cartajena; in the bushes and low trees, flying out after insects, which it caught with much dexterity, and which were very abundant. Mostly small diptera." (C. J. Wood.)

82. TODIROSTRUM NIGRICEPS, (Sclater.)
Todirostrum nigriceps, Sclat. Proc. Zoöl. Soc. Lond. 1855, p. 66.
Proc. Zool. Soc. London, 1855, pl. 84.

From Turbo.

"In the drier parts of the forest at Turbo occasionally seen, but not common. Caught insects of the same description as the preceding, and resembled it in general habits. (C. J. Wood.)

83. TODIROSTRUM EXILE, (Sclater.)
Todirostrum exile, Sclat. Proc. Zoöl. Soc. London, 1857, p. 83.
Proc. Zoöl. Soc. London, pl. 125.

From Cartajena.

"In the bushes and low trees, constantly flying after insects, and uttering a single chirp, by which it could easily be traced and shot. Frequently seen in the month of April." (C. J. Wood.)

84. THAMNOPHILUS ATRICAPILLUS, (Gmelin.)
Lanius atricapillus, Gm. Syst. Nat. i. p. 303, 1788.
Lanius pileatus, Lath. Ind. Orn. i. p. 76, (1790.)
Vieill, Ois. d'Am. Sept. pl. 48, 49, Buffon, pl. enl. 479, fig. 2.

From Cartajena.

"On the Popa mountains at Cartajena, constantly flying across the pathway, and was evidently catching small Lepidoptera and Diptera. Has a prolonged note, somewhat like one note of the cat bird of the United States. Very shy and not easily obtained, though abundant." (W. S. Wood.)

85. THAMNOPHILUS NÆVIUS, (Gmelin.)
Lanius nævius, Gm. Syst. Nat. i. p. 308, 1788.
Lach. Zoöl. Misc., i. pl. 17, Sev. B. of Brazil, pl. 59.

From the Truandó.

"Frequently seen and generally on the ground in patches of plant called Spanish Bayonet by the people of the country, on which it seemed to catch insects. At Camp Palizadas, in January, 1858. (W. S. Wood.)

The plant referred to in Mr. W. S. Wood's note is a species of Fourcroya, (perhaps F. Gigantea, Vent.,) which belongs to a different order from that of which the so-called Spanish Bayonet is a member. The latter is a Yucca, which we do not recollect to have seen through

all Chocó, at least not through that section through which the surveying party traveled. The popular name which the Spanish speaking people give to the Yucca is Pita. The English vernacular originated, undoubtedly, with the American and Texan travelers, and is not known to the natives of New Granada. (Schott.)

86. THAMNOPHILUS TRANSANDENS, (Sclater.)
Thamnophilus transandens, Sclat. Proc. Zoöl. Soc. Lond. 1855, p. 18.

From Turbo.

Appears to be this species having the under tail coverts tipped with white, and is larger than specimens of F. Melanurus in the academy collection; very nearly allied, though, to that species.

"In very thick bushes, on the banks of a creek near Turbo, seen only once and very shy. Has a harsh, loud note, and appeared to be pursuing large insects, occasionally alighting on the ground." (W. S. Wood.)

87. THAMNOPHILUS.

From Turbo.

Two specimens, labeled as females, nearly allied to F. Cæsius (Cuv.) and F. Æthiops, (Sclater.)

88. THAMNOPHILUS.

From the Truandó.

Several specimens, all in young plumage, probably of a species allied to F. Atricapillus.

"All of the preceding five specimens live in the bushes, and are often to be seen on the ground, and appear to subsist by capturing insects in various stages, which are exceedingly abundant. All of them are more or less noisy, having harsh, though not always disagreeable notes, which can constantly be heard where they are frequent. When alarmed, they take long flights very precipitately, and are not easily collected. (W. S. Wood.)

89. PACHYRHAMPHUS RUFESCENS, (Spix?)

From Turbo.

A single specimen in young plumage.

"On the crementina, a high tree with very abundant foliage. Has much the habits of a fly-catcher, darting out in pursuit of insects, and returning to its perch, and moving his tail in the same manner." (W. S. Wood.)

The tree which the natives, in their corrupt negro Spanish, call Trementino, is most common on the banks of the rivers Atrato and Truandó. It belongs to the leguminaceous sub-order, Cæsalpineæ, and its wood, when wounded, exudes a fragrant gum, which by exposure soon becomes tough and sticky. It is probably on this account that the natives apply the misspelled name Terebentino to the tree. This gum seems to be an object of attraction for all sorts of insects,

especially some species of Melipona, and also some of the larger Cimicida, which I saw often caught by hundreds on the viscous exudations of this tree. (Schott.)

Genus PITTASOMA, (nobis.)

General aspect of Conopophaga, Vieillot, but larger and bearing about the same relation to that genus as Grallaria, Vieillot, does to Grallaria, Sclater. Also resembling Pitta, Vieillot, but differing from all the genera here mentioned, except Conopophaga, in having the bill wide and compressed, not depressed.

Form robust; wings short, concave, rounded, fifth, sixth, and seventh quills longest; tail very short; bill strong, wide at base, and narrowing gradually, depressed, upper mandible notched near the lip, and with the culman distinct; a few rudimentary bristles at base; nostrils oval, inserted in a large membrane; legs long, very strong, tonsus with about five large scales in front which become nearly integral on the outside, and quite so behind; toes moderate; claws curved, sharp.

90. PITTASOMA MICHLERI, (Nobis.)

♂ Head above black, the shafts of the feathers lustrous, large space on the cheek, extending completely round the neck behind bright chestnut, throat black, many of the feathers tipped with white and with chestnut, lores white; back reddish olive, many feathers edged with black on each side; rump, upper tail coverts greenish rufous, the last (wing coverts) with small terminal spots of white, which spots are edged and nearly inclosed with black; under parts white, every feather having two or three rather wide, transverse, waved or crescent-shaped bands of deep black; abdomen and under tail coverts tinged with ferruginous, but transversely striped with black, same as under parts of body; under wing coverts dull greenish brown, striped and spotted, with white and black; quills greenish rufous, some of the shorter quills having sub-terminal spots of light rufous, edged with black; tail greenish rufous; upper mandible dark bluish horn color, lighter towards the tip; under mandible yellow; legs bright horn color.

Total length from tip of bill to end of tail about 7 inches; wing $3\frac{3}{4}$; tail $1\frac{3}{8}$; bill (from gape) $1\frac{3}{8}$; tarsus $1\frac{7}{8}$ inch.

Hab. River Truandó; discovered by Messrs. W. S. & C. J. Wood; (Panama, Mr. J. McCleannan;) spec. in Nat. Mus., Washington.

This is the most remarkable bird in the collection, and is one of the most handsome of the ant thrushes, if, indeed, to that group it and the genus Conopophaga belong. Though with the general form and appearance of Pitta and Grallaria, this bird differs from them in having a very strong depressed and rather wide bill—not compressed as in those genera. In this respect, and other structural characters, it approximates to Conopophaga, and also in having more agreeable and variegated colors than in Grallaria. This bird is, in fact, the most handsome bird of its group yet discovered in America. The only specimen in the collection is labeled as a male.

Another and very fine specimen of this bird, kindly loaned me by Mr. Lawrence, of New York, belongs to the collection of J. McClean-

nan, Esq., of that city, and was obtained by him on the isthmus of Panama.

"On the Truandó, January 22, 1858, above its junction with the Atrato, but before reaching the Cordilleras; in the woody places, running on the ground very swiftly and snatching among the leaves; not common." (C. S. Wood.)

This handsome bird I have named in honor of the commanding officer of the topographical party, Lieutenant N. Michler, of the United States topographical engineers, under whose direction, and with whose judicious advice and assistance, the present interesting collection was made, as stated in the preliminary note to this paper.

There is a discrepancy between Mr. C. J. Wood's statement and our original registering, which latter brings the habitat of this bird to Cartajena, where it received the collection number 17, with the special mark of mine, "Forcipirostres," in reference to the peculiarly notched tip of the bill, which singles out this bird from the whole collection. (Schott.)

91. Formicivora grisca, (Boddœrt.)
Turdus griseus, Bodd. Tab. pl. enl., p. 39, 1783.
Formicivora nigricollis, Swain's Zoöl. Journ. ii, p. 147.
Spix. Av. Bras. ii, pl. 41; Buff. pl. enl. 643.

From Cartajena.

"On the Popa mountain, at Cartajena, very abundant in the bushes, but very quick in motion, and shy, flying off on slight noise or alarm, (November, 1857." (W. S. Wood.)

92. Formicivora quixensis, (Cornalia.)
Thamnophilus quixensis et nufiventis, Corn. Sclater.
Myiothera perlata, label in Mus. Acad., Philadelphia.

From the Truandó.

"Both sexes much as given in the descriptions above cited, and labeled by the collectors as male and female of the same species. Abundant at the camp of the Cordilleras, on the Truandó, in the high trees, actively capturing insects, and never observed descending to the bushes. The two plumages are labeled as male and female, were constantly seen together, and were thought by my brother and myself to be the same bird." (W. S. Wood.)

93. Hypocnemis nævioides, (Lafresnaye.)
Conopophaga nævioides, Lafr. Rev. Zoöl., 1847, p. 69.

From the falls of the Truandó.

At Camp Floyd, on the south side of the Truandó, before reaching the first range of the Cordilleras. Running on the ground amongst the bushes, and always in damp or marshy places, much resembling in its actions the water thrush of the United States, (Seiurus noveboracensis.)

Frequently seen in January and February, 1858. (W. S. Wood.)

Camp Floyd is one of Lieutenant Craven's traveling stations in the

swampy section of the Palizadas, about two miles and a half above the camp of that name. (Schott.)

94. MYRMOTHERULA PYGMÆA, (Gmelin.)
Muscicapa pygmæa, Gm. Syst. Nat. i, p. 983, 1788.
Buff. pl. enl., 831.

From the Truandó.

Abundant on the Trementino trees, especially at Camp Palizadas in January, 1858. Frequently seen, also, in the plantain and banana groves, constantly searching for insects amongst the fruit and leaves. (W. S. Wood.)

95. MYRMOTHERULA RUVINAMENSIS, (Gmelin.)
Sitta surinamensis, Gm. Syst. Nat. i, p. 442, (1788.)
Lath. Gen. Thit. iv, pl. 62; Proc. Zoöl. Soc., London, 1858, pl. 141.

From Turbó.

"Frequently seen in the trees at Turbó, and the male was at first supposed by my brother and myself to be the black and white creeper of the United States (Mniotilla varia.) It has habits exactly like those of that bird, running along the upper or lower sides of the branches frequently with its head downwards; in April, 1858. (W. S. Wood.)

The whole of the expedition returned to Cartajena on the 1st of April, 1858, so Mr. Wood's date at Turbó is anticipated. (Schott.)

96. MYRMETHERULA MELÆNA, (Sclater.)
Formicivora melæna, Selat. Proc. Zoöl. Soc., London, 1857, p. 130.

From the Truandó.

At Camp Palizadas, before reaching the Cordilleras. In the bushes, and very active in pursuit of insects. Has a short, rather loud note, often repeated, rendering pursuit very easy; solitary, but frequently seen. (W. S. Wood.)

97. MYRMETHERULA ORNATA, (Sclater.)
Formicivora ornata, Sclat. Rev. et Mag. Zoöl., 1853, p. 840.

From the Truandó.

Several specimens, apparently immature, and not easily to be referred to either M. gularis or its allies, but unmistakably of that ilk.

At Camp Palizadas, on the Truandó, and previously at Turbó, seen in the high trees, and also occasionally in the bushes; very active, and constantly in motion. (W. S. Wood.)

98. MYRMECIZÁ EXSUL, (Sclater.)
Myrmeciza exsul, Sclat. Proc. Zoöl. Soc., London, 1858, p. 540.

From Turbó.

One specimen only labeled as a male, and very nearly as described by Mr. Sclater, as above cited.

99. MYRMECIZA EXSUL, (Sclater.)

From Turbo.

Very similar to the preceding, and probably the same species, but with the entire under parts reddish chestnut brown, nearly uniform with the upper parts; throat only ashy black.

These two birds were considered to be the same species by my brother and myself, notwithstanding the difference in the color of the under parts. We met with this species in the thick and dry parts of the forest at Turbo; rather plenty, but not easily shot, on account of their running on the ground very swiftly and concealing themselves among the leaves. It utters loud, rather musical notes, somewhat similar to those of the golden-crowned thrush (Seiurus) of the United States. (W. S. Wood.)

100. PIPRA AURICAPILLA, (Brisson.)
Manacus auricapillus, Briss. Orn. iv, p. 448, 1760.
Desm. Manak, pl. 60, Hahn & Küster, Orn. Atlas, pl. 92.

From Turbo.

This beautiful little roamer was often observed in December, 1857, along the banks of the Atrato and lower Truandó. There it could be seen gathering in flocks, and continually moving from one bush to another, and then suddenly spreading out again over a grassy main in the bends of these rivers, where they seemed to feed on the seed of some grass of the sub-order, Paniceæ, which grows there in great abundance. That section on the lower Truando, characteristically called "Las Lagunas," appears to have been a principal place of sport for this bird and some of its congeners. (Schott.)

101. PTILOCHLORIS RUFO-OLIVACEUS, (Lafresnaye.)
Ptilochloris rufo-olivaceus, Lafres. Rev. Zoöl., 1858, p. 258.

From the Truandó.

At Camp Palizadas; on the ground; seen once only. (W. S. Wood.)

102. SEIURUS NOVELORACENSIS, (Gmelin.)
Motacilla noveloracensis, Gm. Syst. Nat. i, p. 958, 1788.
Aud. B. of Am., pl. 433; oct. ed. iii, pl. 149.

From Cartajena.

Seen once only in a small stream of water on the Popa mountains in November, 1857. (W. S. Wood.)

103. DENDROICA ÆSTIVA, (Gmelin.)
Motacilla æstiva, Gm. Syst. Nat. i, p. 996, 1788.
Sylvia citrinella, Wilson Am. Orn. ii, p. 111, 1810.
Wilson Am. Orn. ii, pl. 15; Aud. B. of Am., pl. 95, oct. ed. ii, pl. 88.

From Turbo.

Seen for a few days only at Turbo early in April, 1858. (W. S. Wood.) Should be dated March instead of April. (Schott.)

104. Dendroica vieillotii. (Nobis.)
Sylvia ruficapilla, Vieill. Nouv. Dict. ii, p. 228, (but not of same vol., p. 179, and not Sylvia ruficapilla, Lath. Ind. Orn. ii, p. 540, which is Motacilla pelechia, Linnæus, a distinct species.)
Chloris erythrocorides, Feuille, Baird, Rpt. Pac. R. R. Surv. ix, p. 283; hence Dendroica erythrocorides, Baird, same vol., p. 283, (but not Chloris erythrocorides, Feuille, Jour. Obs. Phys. iii, p. 413, 1725, which is Motacilla pelechia, Linnæus.)

Entire head and neck in front reddish chestnut; plumage of all other parts much resembling that of D. æstiva of the United States, but darker on the back, wings, and tail, size rather larger, and with the bill slightly longer and more gradually pointed; total length, 4.5 to 4.75 inches.

Hab. South America, Central America, (Panama, Mr. J. J. Bell.) From Cartajena.

"I have been quite unsuccessful in attempting to find a name really applicable to this well marked and not uncommon species. It is usually, I believe, regarded as Sylvia ruficapilla of authors, and is unmistakably described by Vieillot, as above cited; but erroneously so far as relates to the name, which is applied by all other authors to Motacilla pelechia, Linnæus, a species not uncommon from the West Indies, and accurately figured by Vieillot. Ois d'Am. Sept. pl. 91. Under these circumstances I propose the name above given.

"Frequently seen on the Popa mountain at Cartajena in November, 1857; very active, and constantly moving in the lower trees and bushes." (W. S. Wood.)

105. Dendroica castanea, (Wilson.)
Sylvia castanea, Wilson Am. Orn. ii, p. 97, 1810.
Wilson Am. Orn. ii, pl. Aud. B. of Am. pl. 69, oct. ed. ii. pl. 80.

From Turbo and the river Truandó.

On the Truandó in January and at Turbo early in (April) March, 1858. In small flocks of ten or twelve, in the high trees very much as in autumn in the United States. (Sclater.)

106. Thryothorus nigricapillus, (Sclater.)
Thryothorus nigricapillus, Sclat. Proc. Zoöl. Soc. London, 1860, (p. 84.)

From the Truandó.

"Two specimens appear to be this species, or, at least, very closely allied. They differ only in having the throat transversely banded with black lines, same as on other parts. In low bushes and on the ground on the banks of the river Truandó in the Cordilleras. Frequently seen, and runs on the ground more than usual in the larger wrens of the United States, but has similar general habits." (W. S. Wood.)

107. THRYOTHORUS.

A large plain colored species, for which I have found no name, but am not sufficiently acquainted with the group of Troglodytinæ to feel warranted in proposing a species. Several specimens from Turbo and Cartajena.

108. SCALERURUS BRUNNEUS, (Sclater.)
Schlerurus brunneus, Sclat. Proc. Zoöl. Soc. London, 1857, p. 17.

From the Hingadór.

One specimen only in the collection appears to be this species. On the banks of a small stream called the Hingadór, near the coast of the Pacific ocean. In the palm trees, clinging to the leaves and searching for insects, March, 1858. (W. S. Wood.)

The Hingadór, a tributary of the Nercua, has its sources some six or seven miles distant from the Pacific ocean. The party left the mouth of this little Atlantic stream early in February to return to the Gulf of Urabá and Cartajena. (Schott.)

109. SYNALLAXIS CANDEI, (D'Orb. et. Lafresn.)
Synallaxis Candei, D'Orb. et. Lafresn. Rev. Zoöl. 1858, p. 105.

From Cartajena.

110. XENOPIS RUFICAUDA, Vicillot.
Synallaxis ruficauda, Vicill. Nouv. Dict. xxxii, p. 310, 1818. Temm. pl. col. 150.

From Turbo.

111. DENDRORNIS TRIANGULARIS, (Lafresnaye.)
Dendrocolaptes triangularis, Lafresn. Mag. Zoöl. 1643. Guerin. Mag. Zool., 1843, pl. 32.

From the Truandó.

"These kinds of birds were very abundant on the trees in the Cordilleras, and a few were seen at Camp Palizadas, on the Truandó, within 20 or 30 miles of the mountains. They run on the trunks and branches very rapidly, and appear to be very greedy and rapacious. Not shy, and easily approached, but not easily shot at on account of their quick movements. When they have ascended a tree they fly down to the base of another, like the brown creeper of the United States, (Certhia.)" (W. S. Wood.)

112. DENDRORNIS GUTTATUS, (Lichtenstein.)
Dendrocolaptes guttatus, Licht. Ven. p. 16, 1823.
Le. Vaill. Prom. pl. 30.

From the Truandó.

113. DENDRORNIS.

One specimen from the Truandó with large elongated spots, for which I have not succeeded in finding a name.

114. MALACOPTILA.

From the Truandó.
A single specimen in immature plumage, referable to no species with which I am acquainted.

115. CERTHIOLA LUTEOLA, (Cabanis.)
Certhiola luteola, Cab.

From Turbo and Cartajena.

116. JULIAMYIA JULIÆ, (Bourcier.)
Juliamyia typica, Bonap. Rev. Zoöl. 1854, p. 255.
Ornismyia Juliæ, Bourc. Ann. Soc. Lyons, 1841, p. 345.
Gould. Monog. pt. xviii, pl. (not numbered.)

From Turbo.
"Seen occasionally in March, (not April,) 1858, but not very common; flies very swiftly, and is shy, darting away on the least alarm." (W. S. Wood.)

117. CHRYSOLAMPIS MOSCHITUS, (Linnæus.)
Trochilus moschitus, Linn. Syst. Nat., i. p. 192, 1766.
Gould. Monog., pt. xii, pl.

From Cartajena.
"About an old fort in the Popa mountain, which was completely overgrown with vines and flowering plants, this humming bird and others were exceedingly abundant. Constantly flying and fighting with each other, and nowhere seen so abundant as here in the month of November, 1857." (W. S. Wood.)
The old fort referred to by Mr. Wood, is Fort San Felipe, situated between the town of Cartajena and the so-called Popa mountain, from which the former stands detached. As Mr. Wood says, this whole hillside, with its impenetrable thickets, was found to be an inexhaustible locality for objects of the fauna as well as for the flora of this vicinity. (Schott.)

118. LAMPORNIS MANGO, (Linnæus.)
Trochilus mango, Linn. Syst. Nat., i, p. 191, 1766.
Gould. Monog. pt. xii, pl.

From Cartajena. Appears to be the true mango of authors.

119. EUCEPHALA CÆRULEA, (Vieillot.)
Trochilus cæruleus, Vieill. Nouv. Dict., vii, p. 361, 1817.
Gould. Monog. pt. xiv, pl.

From Cartajena.

120. IONOLAIMA.

From Turbo. One specimen only, in bad condition and immature plumage, appears to be of this genus.

121. PHÆTORNIS YARUQUI, (Bourcier.)
Trochilus Yaruqui, Bourc. Compt. Rend., xxxii, p. 187.
Gould. Monog., pt. iv, pl.

From the Truandó.

"Plain plumaged humming birds were frequently seen on the Cordilleras, but never very abundant. We rarely saw the brighter colored in the mountains. Generally about the vines and shrubbery." (W. S. Wood.)

122. PHÆTORNIS.

From Turbo. A single specimen, in immature plumage, of a small species.

123. CHLOROENAS RUFINA, (Temmink.)
Columba rufina, Temm. Pig. et Gall., i, p. 467, 1813.
Knip. Pigeons, i, pl. 24.

From Turbo and the delta of the Atrato.

"Seen once only at Turbo, in a small flock, sitting in a high tree, and once only at the mouth of the Atrato. Seemed to be a stranger. Early in January, 1858." (W. S. Wood.)

Mr. Wood, like the rest of the party, did not return to the Gulf of Urabá and Turbo before February 26, 1858. (Schott.)

124. LEPTOPTILA VERREAUXII, (Bonaparte.)
Leptoptila Verreauxii, Bonap. Consp. Av., ii, p. 73, 1854.

From Turbo and the river Truandó.

"From a secluded part of the forest at Turbo, in the trees, and afterwards on the Truandó." (W. S. Wood, jr.)

This is probably the species the peculiar note of which was so frequently heard all along the Truandó, especially within the heavy timbered lowlands. The note of this bird is exceedingly well characterized by the native phrase, "Oh chocó!" "Oh chocó!" as our negro laborers from Cartajena imitated it. In the dead silence which rules the tropics during noon hours, the note of this dove was the only sign of animal life which could be heard. (Schott.)

125. CHAMÆPELIA GRANATINA, (Bonaparte.)
Chamæpelia granatina, Bonap. Consp. Av., ii, p. 77, 1854.

From Cartajena.

"Abundant, and in large flocks among the bushes on the shores of the sea at Cartajena, in November, 1857. Seemed to be searching for food in the sand and short grass, and not very easily approached, flying away very rapidly, and frequently alighting on trees." (W. S. Wood.)

We here take occasion to mention two more species of this order, which have been noticed, though no specimens were secured for the collection. The one was heard only in the forests covering the dividing ridge between the Nercua and the Pacific coast. The note, sounding from very high trees before and about day break, was a loud

but very low k-r-r-r-r! k-r-r-r-r! To the natives, this bird seems to have been very well known, as they also had a vernacular name for it, which, unfortunately, escaped my memory before I could write it down.

The other species is, if I mistake not, Chamæpelia passerina? (Linnæus,) or some closely allied species. We saw it frequently about the sea-beach on the Tierra Bomba, and towards the Bay of Tesco, near Cartajena. This little dove is an old acquaintance of mine, which I often observed upon the open, arid table lands bordering the Lower Bravo del Norte. At another time, in autumn, 1851, one of these coast-loving little birds came aboard the "Golden Age," when this steamer, on her trip between Panama and San Francisco, was sailing along the coast of Lower California. We must have been at that time considerably off that coast, for though bold and mountainous, it was out of sight entirely. This pretty little species goes among the people of Mexico under the name Abuelitas, that is, little grandparents.

126. TINAMUS MAJOR, (Gmelin.)
Tetrao major, Gm. System Nat. i, p. 767. 1788.
Pezus serratus, Spix. Av. Bras. ii, p. 61, 1825.
Buff. pl. enl. 476, Spix. Av. Bras. ii, p. 76.

From the Truandó.

One specimen only, labeled as a female, which appears to be identical with specimens from Brazil.

"Frequently heard on the Truandó near the first range of the Cordilleras. It has a very loud, continued note, not inappropriately compared by the members of our party to the whistle of a locomotive engine; not easily seen, being exceedingly shy and running very rapidly." (W. S. Wood.)

The very loud, continued note, which Mr. Wood ascribes to this bird, was more probably the yell of the Danta, (Tapir,) for it equals that of an "engine whistle" in force and intensity, which to produce would be an utter impossibility for a comparatively small bird like the Tinamus. Of this bird no traces were noticed until we reached the hill and mountain sides on the upper Truandó, where members of the gallinaceous family generally made their appearance, such as the Paba and Pauxi, (Penelope Marail and Urax.) In this section of country we several times observed the Tinamú or Guacharaca, as the Chocó Indians call it, hastily pushing in flocks through the undergrowth or patches of dense grass. The whistling note which, during our stay in the swamps of the Palizadas, and even further below in the country, was regularly heard every evening about sundown, ceased to be our "camp tardoo" with the gradual elevation of the ground. The cry of the Tapir, as we heard it, is known and described as a whistling yell. The Chocó Indians on the Truandó call the "Tinamú" Huacharaca or Guacharaca—the meaning of which we could not learn. The name Tinamú undoubtedly is derived from Ynambú carape, as the Guaranis of Brazil call this bird.

The name Guacharaca does not seem to be strictly given to one species, as in other parts of New Granada some species of Ortalida bear also the name Guacharaca and Gu. de montaña. (Schott.)

Though not mentioned in Mr. Cassin's catalogue, we have to state here the common occurrence of a large bird on the banks of the Atrato, called by the natives "Cabrilla or Cavaria," which is undoubtedly the Chaju of others, (Palamedea chavaria, of Gould,) and Chaura chavaria of other authors. One male specimen under the number 84 was added to the collection on the Atrato. This bird, though making itself conspicuous almost everywhere on the banks of this river, seems to be very cautious to keep out of a gun's range, and even in cases of its having been brought down, it will retreat to some inaccessible spot, and rather become the prey of some hungry cayman. (Schott.)

127. SQUATAROLA HELVETICA, (Linnæus.)
Tringa helvetica, Linn. Syst. Nat. i, p. 250, 1766.
Charadrius apricarius, Wilson Am. Orn. vii, p. 41, 1813.
Wilson Am. Orn. vii, pl. 57; Aud. B. of Am., pl. 334, oct. ed. v., pl. 315.

From Cartajena.

128. SYMPHEMIA SEMIPALMATA, (Gmelin.)
Scolopax semipalmatus, Gm. Syst. Nat. i, p. 659, 1788.
Wilson Am. Orn. vii, pl. 56; Aud. B. of Am., pl. 274, oct. ed. v, pl. 347.

From Cartajena.

129. GAMBETTA MELANOLEUCA, (Gmelin.)
Scolopax melanoleucus, Gm. Syst. Nat. i, p. 659, 1788.
Scolopax vociferus, Wilson.
Wilson Am. Orn. vii, pl. 58; Aud. B. of Am., pl. 288, oct. ed. v, pl. 344.

From Cartajena.

The name "Pisisí," in the language of the Darien and San Blas Indians, probably applies to this bird especially, if not to most of its allies. With "Pisisí" these Indians imitate the note of these birds, and thus the name may have originated. The site where the present village of Turbo is built on, originally bore the same name, on account of a small strip of sandy beach there, which is frequented by these birds. Afterwards—that is some years ago—the government of New Granada substituted for it the name of Turbo, which is taken from a small river in that neighborhood.

130. GAMBETTA FLAVIPES, (Gmelin.)
Scolopax flavipes, Gm. Syst. Nat. i, p. 659, 1788.
Wilson Am. Orn. vii, pl. 58; Aud. B. of Am., pl. 228, oct. ed. v., pl. 344.

From Cartajena.

131. CALIDRIS ARENARIA, (Linnæus.)
Tringa arenaria, Linn. Syst. Nat. i, p. 251, (1766.)

Calidris Americana, Brehnr.
Wilson Am. Orn. vii, pl. 59, 63; Aud. B. of Am., pl. 250, Oct., ed. v, pl. 338.

From Cartajena.

132. EREUNETES PUSILLA, (Linnæus.)
Tringa arenaria, Linn. Syst. Nat. i, p. 252, 1766.
Tringa semipalmata, Wilson.
Eurenetes petrifactus, Illiger.
Wilson Am. Orn. vii, pl. 63; Aud. B. of Am., pl. 408, oct., ed. v, pl. 336.

From Cartajena.
This is, I have no doubt, the true Tringa pusilla of Linnæus

133. TRINGA WILSONII, (Nuttall.)
Tringa Wilsonnii, Nutt. Man. ii, p. 121, (1834.)
Tringa pusilla, Wilson.
Wilson Am. Orn. v, pl. 37; Aud. B. of Am., pl. 320, oct., ed. v, pl. 337.

From Cartajena.
"The preceding seven species, and, in fact, nearly all the small wading birds that we had been accustomed to seeing on the coast of New Jersey, were very abundant on the sea coast at Cartajena in November, 1857. The most abundant were perhaps the two small sandpipers (E. pusilla and T. Wilsonii) and the yellow-shanks (G. flavipes.) Though easily shot, they were not so easily obtained, on account of the marshy or boggy character of many localities which they particularly frequented. All of these species were in flocks, as seen on the coast of the United States in autumn." (W. S. Wood.)

134. PARRA HYPOMELÆNA, (G. R. Gray.)
Parra hypomelæna, Gray, Gen. iii, p. 589, 1846.
Gray, Gen. iii, pl. 159.

Atrato river.
In open places which are very marshy on the river Atrato, late in December, 1857. Two or three together; generally on the ground; frequently stretching out their wings, and often wading in the water. "Quite shy and watchful." (W. S. Wood.)

Among the feathery population adding to the peculiar aspect of the extensive swamps and marshes adjacent to the rivers Atrato and Truandó, this bird is not the last. It is one of the most graceful sights, indeed, to see these delicately built Hotspurs making their animated evolutions on the wing, and moving to and fro from bank to bank, or, again, taking a quiet sail on one of those many flowery islands which are constantly floating down on the broad sheet of the Atrato. Here and there they follow their sport for water-worms and insects inhabiting those depositories of aquatic plants, temporarily moving along the river banks or on those migratory vegetable colonies rafted together with dead material of drift wood, brush, and cane, and

leisurely descending with the currents of the stream. There the Jacanas appear sometimes, associated with one or two smaller forms of herons, or a small Kingfisher, (Ardea candidissima, Butorides grisea, and Ceryle amazona,) and a lazy young cayman stretched to take a sunny airing.

The Jacanas seem to have home and sport all the year round in the localities mentioned; at least they were observed by us in rather increased numbers at the time the party returned through the Lagunas of the Truandó to Sucio and Turbo. This numeric increase seems to have been caused at the close of the dry season in February by the general reduction of all the backwaters and smaller affluents of the river, in consequence of which all aquatic animal life appeared concentrated within a smaller compass, where its wants could be satisfied.

To judge after external appearance, there may have been a variety, if not another species besides the one cited above. Seeing this difference in the plumage, at first we thought the birds to be male and female, but, noticing always two or three like ones resting and moving together, we concluded that they may be of some specific difference. The second form, being all over the body more brown, had but very little of the velvety black of the former about it. This caused in general a less striking show of the brighter colors with which P. hypomelæna is adorned. (Schott.)

135. ARAMIDES CAYENNENSIS, (Gmelin.)
Fulica cayenensis, Gm. Syst. Nat. i, p. 700, 1788.
Buff. pl. enl. 352.

From Turbo.

In a salt water marsh at Turbo; seen once only. (W. S. Wood.)

Some of the natives on seeing this bird called it "Salicado"—the meaning of which we do not understand, if not perhaps its habitat in the salt marsh has anything to do with it. They also maintained as if this bird were able to bring forth the most curious notes by means of some "pseudo larynx" about the abdominal parts of its body. We ourselves have not been able to discover such a backward escape valve for the use of this suspected ventriloquist; so we remain skeptic about the matter, the more so as we know the negro disposition of trying to impose upon credulous strangers, and to graft upon them their own superstitious notions. It is true, however, that many members of the orders of Grallatores and Natatores possess notes of the most peculiar sounding, much resembling some whooping ventriloquism. (Schott.)

136. ARDEA HERODIAS, (Linnæus.)
Ardea herodias, Linn. Syst. Nat. i, p. 257, 1766.
Wilson Am. Orn. viii, pl. 65; Aud. B. of Am., pl. 211, oct. ed. vi, pl. 369.

Frequently seen about the delta of the Atrato. (W. S. Wood.)

This form of "Herons" was found to be the most common all along the Atrato and lower Truandó, but appears to be very shy and watchful. The specimen in the collection was secured by Mr. Charles Heine, of the hydrographical party. It was brought aboard wounded and in

a very defying mood, and evinced, while it was to be killed, proofs of the toughest vitality imaginable. (Schott.)

137. Butorides grisea, (Boddaert.)
Cancroma grisea, Bodd. Tab. pl. enl. p. 54, 1783.
Ardea scapularis, Illiger.
Buff. pl. enl. 908.

From Cartajena.

138. Garzetta candidissima, (Gmelin.)
Ardea candidissima, Gm. Syst. Nat. i, p. 633, 1788.
Wilson Am. Orn. vii, pl. 62; Aud. B. of Am., pl. 242, oct. ed. vi, pl. 374.

From Cartajena and the river Atrato.

"Abundant on the Atrato in February, 1858; generally seen sitting on the low trees on the edge of the river." (W. S. Wood.)

Sometimes members of this species gather in great numbers, usually about sundown. The first sight we had of this bird at our arrival in the bay of Cartajena, near Paso Caballo, where from fifty to sixty were perched on one low tree which overtopped the surrounding mangrove thickets; they looked as if they had retired there for the night, and appeared entirely unconcerned about the movements of our approaching schooner. A similar sight offered to us a large group of the same birds which occupied some low bushes in the mouth of Coquito, one of the outlets of the Atrato. (Schott.)

139. Tigrisoma brasiliense, (Linnæus.)
Ardea brasiliense, Linn. Syst. Nat. i, p. 239, 1766.
Buff. pl. enl. 860.

From the delta of the Atrato.

140. Tigrisoma tigrinum, (Gmelin.)
Ardea tigrina, Gm. Syst. Nat. ii, p. 638, 1788.

From the delta of the Atrato.

Both Nos. 139 and 140 were secured by Mr. Charles Heine, near the mouths of Pichindí and Pichindicito, at the southern end of the Atrato delta. (Schott.)

141. Harpirion cayennensis, (Gmelin.)
Tantalus cayennensis, Gm. Syst. Nat. i, p. 652, 1788.
Buff. pl. enl. 820.

From the river Nercua.

This seems to be one of the most lazy or unsuspicious birds of an order which is generally known as very watchful; the shooting of both specimens of the collection seems to prove this. The first one was shot on the Truandò, just opposite the mouth of the Nercua, by myself, and with a gun so much out of order that it was hardly fit to be carried about with any degree of security; the hammer would not

rest cocked or half cocked; the moist climate and our constantly living on damp and boggy ground, had unfitted almost every one of our fire-arms. Shortly after daybreak our tantalus walked along the water's edge hunting for an early breakfast, and did not seem to heed much my presence, for I was lying stretched out on my blankets scarcely ten yards from it; the bird for a moment gazed at me passing the nearest point from where I was, and then permitted me to get up and go to where the rest of the party were sleeping. There I took my gun, returned to my camp, sat down and capped it afresh; then my index finger holding back the cock, I took aim and the gun snapped; the bird did not mind such lubberly proceeding, hunted worms again, but in the twinkling of an eye, and poor crook-bill was at the disposal of science. In a similar manner the other specimen was secured by Mr. W. S. Wood, who used the same gun one or two days afterwards, when the good old piece snapped again, and the bird flew off, but only for a short distance, soon alighting again for the last time of its life. (Schott.)

142. Dendrocygna autumnalis, (Linnæus.)
Anas autumnalis, Linn. Syst. Nat., i, p. 205, 1766.
Baird B. of N. Am., pl. 63; Rept. Mexico Bound. Survey, Birds, pl. 25.

From the Truandó.

143. Carbo brasilianus, (Gmelin.)
Procellaria brasilianus, Gm. Syst. Nat., i, p. 564.
Gilliss Astr. Expd. Birds, pl. 28.

From the Truandó.

"On the Truandó and Atrato. Frequently seen in the water, and also on trees. When perched, drop very suddenly into the water on being alarmed, and disappear by diving." (W. S. Wood.)

144. Plotus anhinga, (Linnæus.)
Plotus anhinga, Linn. Syst. Nat., i, p. 580, (1766.)
Plotus melanogaster, Wilson.
Wilson Am. Orn., ix, pl. 74; Aud. B. of Am., pl. 316; oct. ed. vi, pl. 420.

From the rivers Atrato and Truandó. Several specimens in immature plumage, but all apparently of this species.

"Abundant in the months of January, February, and March, on all the rivers from the Gulf of Darien, on the Atlantic, to the coast of the Pacific." (W. S. Wood.)

In presenting the above catalogue, we desire to add a few words on the localities mentioned therein.

A general idea of the country and its natural sections is necessary to properly understand their values in regard to their respective fauna. For this we refer the reader to the "Physiographical table," (Appendix K.)

As in the catalogue on birds, only few distinct localities are given. Where the collection received its principal additions, one could suspect a somewhat sporadic distribution of species, which is not the case. These given localities must be considered at least as topographical types of those sections in which they are situated. There were certain points, where the nature of the duties of the expedition required the occasional sojourn either of the whole party or of a single detachment. Such a locality was often occupied for several days, or even so many weeks. Here was naturally the best opportunity to complete observations and add most to the collections.

The first of these places was the old town of Cartajena and its next neighborhood. About a fortnight was spent there for completing the organization of the expedition.

Next was Turbo, on the Gulf of Urabá, (Darien,) where several days were employed for commencing the hydrographical work. On our return from the Pacific shores, we had to wait here again four weeks for the completing of the hydrographical work.

At Camp Palizadas, fourteen days passed before the survey commencing there had advanced so far as to allow the party to move higher up in the country.

The Falls of the Truandó were another station to wait for the surveying party to come up and move on. At this point a small detached party, consisting of Mr. Charles J. Wood and one of the officers, remained for twenty days to attend to the observatory, while all the rest were going on towards the Pacific.

At the mouth of the Nercua, several days were spent by a small detachment in order to wait for the rest to come up. Our movements at that time were much impeded by the almost entire lack of transportation.

At the mouth of the Hingadór, and on the Pacific coast, we spent two days each. At the two latter stations, however, little could be done for science, for each man, officer and crew, had to carry his own baggage. Now, considering these various localities as representing the respective sections they are situated in, we have each with a corresponding fauna.

Cartajena, characterized by open sea-beach, and a light timbered or shrubby cover of surrounding flats and hill-sides.

Turbo, by heavy forests, salt marshes, and mangroves, like the delta of the Atrato on the opposite side of the gulf.

The *Atrato*, by marshy flats, alternating with heavy timbered banks with extensive backwater lagoons.

The *Lagunas* of the Truandó, by open glades, interspersed with numerous islands and hummocks formed by more or less indifferent timber.

The *Palizadas*, (of the Lower Truandó,) by swamps, under cover of the heaviest ever shady forests.

The *Falls of the Truandó*, by rising ground, rocky mountain sides, heavy timber, and a more regulated drainage.

The *Nercua*, by dense forests alternating with genial openings.

The *Dividing Ridge*, (scarcely represented in our collection,) by heavy forests and strong drainage.

Whatever the merits and deficiencies of our ornithological collection

may be, it is certain that no one is able to properly appreciate the efforts of the collectors who himself never traveled under similar circumstances, through a tropical region, like the one described within these pages.

ARTHUR SCHOTT.

GEORGETOWN, *D. C.*, *January* 27, 1861.

XIV.

APPENDIX G.

ZOÖLOGY—REPTILES AND AMPHIBIA.

REMARKS BY ARTHUR SCHOTT.

Of these two classes no special examination has yet been made. Dr. Charles Girard, formerly of Washington city, on inspecting our collections in the Smithsonian Institution, estimates them to contain about 40 species.

The order of Chelonia appears to be the least represented in the collection, as we obtained but one single shell of a fresh water species living in the waters of the Atrato. There is enough proof, however, that this peculiar order is very well represented all through Chocó.

The order of Loricata, though having but one representative in the collection, stands, nevertheless, foremost in the class, as well by the numeric distribution of the species as also by the monstrous size which it seems to attain in the regions bordering the Atrato and its primary tributaries. The species, if not identical, is nearly allowed to Humboldt's Crocodilus acutus, which, if we err not, also inhabits in large numbers the Magdalena river.* The depositories of alligator eggs, which we found occasionally along the sandy beach of the upper Truandó, furnished a welcome addition to our scanty means of subsistence. When old, however, these eggs emit an offensive musky odor—the same which is peculiar to the alligator itself.

Next in order are the Sauria, among which the Iguana is most prominent. This animal we were not able to distinguish from Iguana tuberculata. Its swiftness and agility, which it exhibits on the ground as well as also in the water or again in the treetops, make this reptile most remarkable. The Iguano is always, but especially when the Iguanas are to deposit their eggs, a much desired object of sport for the Indians, who live on their meat both fresh and smoked; they also use exclusively their eggs, which they boil, or bake in hot ashes. The Iguana egg is indeed a delicacy which we are only able to compare with those of the quail.

Nearly related to the Iguan is the Basilisk, (Basiliscus mitratus,) which inhabits the same regions with its congener, but appears to be of rarer occurrence. The Basilisk seems to equal in liveliness and agility the Iguan.

* We were lately informed that the species is a true Alligator.—S.

In regard to Ophidia we have to state that our party, when working across the Isthmus during the dry season, encountered a far less number than we had anticipated. There is reason to believe that the numerous droves of Peccaries, which during the rainy time and the season of overflows are excluded from the regions along the Atrato and its tributaries, must sport freely through these lowlands when uncovered by water. In consequence a great number of snakes on leaving their arboreal retreats must be destroyed by these roaming pachyderms. Besides the specimens obtained, we observed five or six more forms of this order, which may belong to as many species. Their swiftness as well as the much obstructed nature of the ground prevented us from securing them for our purposes.

The class of Amphibia appears also very well represented on the Isthmus, and our collection contains quite a diversified series of forms. The relation to man, of this class of animals, seems to be very unimportant; there is one interesting notice, however, made by General T. C. de Mosquera in his essay on the physiography of New Granada, in which he states, page 38:

"*Y es notable una rana amarilla, timida é inofensiva, de que sacan los Indios de Chocó y Barbacoas un veneno activisimo para sus flechas y dardos, de un humor acre que sudan, poniéndolas sobre un poco de rescoldo. Despues de esto martirio, largan la rana otravez en el bosque, para que no muere y poderse servir de ella en otra ocasion.*"

There is an interesting yellow frog, timid and inoffensive, from which the Indians of Chocó and Barbacoas procure a most active poison for their arrows and darts, by holding the animal over a gentle heat so as to make the skin exude an acrid humor; this done, they set the animal free again, in order to serve them at some other time after it has recovered its former vigor.

XV.

APPENDIX H.

ZOÖLOGY.—THE FISHES.

BY THEODORE GILL, ESQ.

NOTE.—The subjoined letter from Theodore Gill, Esq., contains a preliminary classification of the fishes obtained in the waters of Chocó. Though it was impossible, for the present, to give a closer specific identification of the specimens, Mr. Gill's valuable contribution may prove sufficient for the characterization of this branch of the fauna of Chocó.

A. S.

SMITHSONIAN INSTITUTION,
Washington, D. C., January 14, 1861.

DEAR SIR: Your note requesting me to furnish you with a catalogue of the fishes obtained by you on the expedition for a survey of an interoceanic ship canal, *via* the Atrato and Truandó rivers, under the orders of Lieutenant N. Michler, topographical engineer, United States Army, has been duly received. I regret that my time is so fully occupied at present, that I am unable to render a report containing descriptions of the new species collected. I am further prevented from giving descriptions of the apparently new species, as some of the recently published memoirs on the fishes of different parts of South America are not now accessible. I have made a cursory examination of the collection, and find that there are some interesting forms. Desirous of obliging you, I will furnish a list of the genera to which the species belong.

With the exception of a single species of Ray of the genus Trygon, all the fishes of the collection belong to the subclass called by Müller Teleostei. Those species represent four of the orders, as restricted by me in a memoir on the classification of fishes introductory to a catalogue of the fishes of the eastern coast of North America; the orders so admitted are there called Teleocephali, Nematognathi, Plectognathi, and Lophobranchii.

Of the Teleocephalous fishes, representatives of nineteen genera are present in the collection. They belong to the families enumerated below.

Of the family of Percoids there are three species, which belong to as many different genera and subfamilies.

There is one specimen of the genus Centropomus of Lacepede, a member of the subfamily of Percinæ.

Of the genus Epinephelus, of Bloch, there is also a species; it represents the subfamily of Serraninæ.

Both the above species are well known. The Centropomus is the true Centropomus undecimalis of Cuvier.

Several species of the genus have been recently described by Rey, all of which inhabit the waters of the Island of Cuba.

Of Lutjanus, the typical genus of a peculiar subfamily, Lutjaniæ, there is also a species.

The family of Pristipomatoids and subfamily of Pristipomatinæ is represented by a single species of the genus Hæmulon of Cuvier.

There is a species of the genus Gerres of Cuvier very nearly allied to the Gerres-gula of Cuvier and Valenciennes. It belongs to the subfamily of Gerrinæ and the family of Mænoids.

Of the Scombroid family there is a species of Cybium.

Of the Carangoids, a species of the genus Carangus.

Of the family of Echenoids and the genus Echeneis there is one representative.

Of the family of Scomberesoces and the subfamily of Hemirhamphinæ there is one species, which belongs to the genus Hemirhamphus of Cuvier.

The family of Chromoids or Ctenolabroids is represented by four species, which belong to the genera Cichlasoma of Swainson, Geophagus of Heckel, and Heros of Heckel. All of these belong to one family, for which the name of Chrominæ is acceptable.

The suborder of Physostomi is represented by the families of Characinoids and Erythrinoids. There are species of the following subfamilies and genera:

Of the family of Characins;
Subfamily of Pacuinæ;
Genus Pacu, of Spix;
Subfamily of Leporininæ;
Genus Leporinus, of Spix;
Subfamily of Tetragonopterinæ;
Genus Astyanax, of Baird and Girard, or

Pœcilurichtys of Gill.

Subfamily of Xiphostominæ;
Genus Ctenolucinus of Gill;
Subfamily of Hydrocyoninæ;
Genus Cynopotamus of Valenciennes.

Of the family of Erythrinoids there is one representative.

Subfamily Erythrininæ;
Genus Macrodon of Müller and Troschel.

There is also a fine new species of the family of Gymnotoids.

Subfamily Carapinæ;
Genus Sternopygus of Müller and Troschel.

One representative of the order of Lophobranchii was obtained.

Family of Syngnathoidæ;
Subfamily Syngnathinæ;
Genus Syngnathus, of Linnæus.

Of the order of Plectognathi there is one species.

Family of Tetraodontoidæ;
Subfamily Tetraodontinæ;
Genus Gastrophysus of Müller and Troschel.

Of the subclass of Elosmobranchii and order of Plagiostomes there is also a single species.

Family Trygonoidæ;
Subfamily Trygoninæ;
Genus Trygon of Adanson.

I have given no specific names to any of the above species, although several are new, as it is uncertain when I will be able to describe them, and it would also be injurious to the progress of science to add to the synonymy by the publication of names of species which may be, before they can be described under those names, made known under other names.

Very truly, yours,

THEO. GILL.

ARTHUR SCHOTT, Esq.

XVI.

APPENDIX I.

ZOÖLOGY—INVERTEBRATÆ.

After the collection of Invertebratæ had been safely received at the Smithsonian Institute, they were classed and distributed for special examination.

The Coleoptera and Hymenoptera were sent to Europe, as there are not in this country the proper facilities for comparing and studying extra North American species. Other orders are still in the hands of scientific gentlemen in this country.

Until now only few returns have been made, and these, on account of the insufficiency of the material, must necessarily be also deficient, especially as far as systematic arrangement is concerned.

We are, therefore, only able to introduce here a mere outline characterization of our collected matter, which may serve as a handmaid to Physical Geography.

COLEOPTERA.

Only from the Palisades upwards through the low and table lands, where collections have actually been made, and, perhaps, by supposition about the adjoining region of the divide, some idea can be formed about the coleopterous groups forming part of the fauna of the Isthmus of Chocó.

The following genera have been observed to be prominently represented:

1. *Phytophaga.*—Rynchænis; Calandra, among which that large species C. palmarum; Bruchus; Galleruca; Chrysomela; Cryptocephalus? Cassida; Allecula; Apate? Bostrychus; Collydium? Elater, represented by various forms, most prominently by the celebrated Cucuyo of the natives; E. noctilucus; Buprestis; Clytus; Callidium; Saperta; Lamia; to which group belongs that xylophagus giant, (Lamia,) Acrocinus longimanus.

Of this beautiful species, several fine specimens have been obtained in one locality, on a large caoutchouc tree. After I had caught the first one, I saw two or three more rising from the same spot. The next day one of the assistants, to whom I had mentioned the hour of the forenoon when I had observed the others, went to look out for them. He succeeded in obtaining four or five more.

The genus Cerambyx closes our series of phytophagus coleoptera.

2. *Zoöphaga.*—Staphylinus, Carabus, Cicindela, Clerus, Sympyris, Cantharis, Lytta, and Coccinella.

3. *Cryptophaga.*—Scarabæus and Copris.

Scarabæus Hercules? Only the thorax of a dead specimen was brought to us, in Turbo, on the Gulf of Urabá.

ORTHOPTERA.

Of this family a pretty full collection was secured, in about the same region with the Coleoptera.

1. *Grillinæ.*—Here to be mentioned are the Gryllotalpa, Satr., and Acheta, Fabr.

2. *Locustinæ and Acridinæ.*—Of these a far greater variety was secured. Genera of the former probably prevail in the low lands of the Palisades, while the latter appear not less diversely represented through the more elevated portion of the country.

We especially mention here some interesting forms of ¿ Phylloptera?

Of the group *Phasmodea,* various specimens were collected; among them one which we believe to belong to the genus Bacillus, Satr., (perhaps B. calamus.) One of them measured more than five inches in length. Several members of the genus Phyllium were also caught within the limits of the Palisades and the lowlands. The group

Mantidea seems also to be well represented there. One species near Mantis Strumaria was noticed. The immense amount of decaying vegetable matter within the tropics naturally favors the increase of the group

Blattina, which, numerically as well as generically, are well represented on the isthmus. Various forms were added to the collection. They probably are closely related to the genera Panchlora and Blabera.

CORRODENTIA.

The daily observed extensive work of destruction of wood, accomplished by some species of the genus Termes, lead us to the conclusion that their distribution must be almost unlimited.

What was collected of *Ephemerina* and *Libellulina** is but little; but according to our cursory observations, an endless variety of forms belongs to the fauna of the isthmus.

The genus Myrmecolcon, L. seems to enjoy here a very rich field for sport. Great numbers, especially of their "larvæ," were secured.

HYMENOPTERA.

Among the various forms belonging to the groups *Formica* and *Myrmica,* a gigantic black and aculeate species was collected. It resembles much F. Herculeana, and must be closely allied to it. Also

*NOTE.—Through the kindness of Baron Robert Von Osten Sacken, of the Russian legation, we are informed of the recent determination of three species of this interesting family by Hagen, whose catalogue is soon to be published under the auspices of the Smithsonian Institution. The species belonging to our collection are: *Erythemis bicolor,* Erichson; *Diplax ochracea,* Burm; and *Gomphoides tenuis,* Hagen.

another species was obtained, which, perhaps, may prove to be identical with Atta cephalotes of Satr.

Mutillaria.—This family is also represented here, but apparently in a less degree than I had occasion to observe on the dry table lands adjoining the Lower Bravo del Norte.

Apiformia and *Vesparia.*—A small collection of these two groups has been forwarded, through the Smithsonian Institution, to Europe. No return has been received yet.

In the economy of the country, bees form a very prominent feature. Of a small black species, probably a Melipona, the Chocó Indians use the black wax, which has a resinous, pitchlike appearance. We were told that this wax cannot be bleached.

Of wasps, a gigantic species, with a bluish black body and red wings, was secured, which probably belongs to the group of Pepsis. Its specific affinities bring it near a species of the subtropic fauna of Western Texas and Northern Mexico. There I observed it several times to be a deadly enemy of a large Mygale, (Tarantula of the Texans.) The large Arachnid, according to my observations, fell invariably a prey to its winged antagonist.

LEPIDOPTERA.

Little could be done in the field regarding this family, for our means of transportation and mode of traveling precluded a more thorough collection of members belonging to it. Only a few specimens were obtained. They are Papilio Polycaon, Fabr.; Argynnis, sp? Morpho Adonis, Cram. This is the lepidopterous beauty mentioned by Lieutenant Michler. (See his report.) Heliconia (sp.) somewhat resembling H. Eva; Nymphalis, (¿Thetis, Fabr.?) N. Orsilochus, Godd., very much resembling it, if not identical.

N. ¿Decius? and N. ¿Portia? Two species of Catocala were also collected. Of these the larger form is identical with a species of our southern fauna, which I often observed and collected on the lower Bravo del Norte. It is one of the monster sized Lepidoptera. The flight of this shadow-loving insect gives it to unwonted eyes the appearance of a bat.

The smaller species, like its congener of a pretty uniform somber color and similar habits, seems to be nearly related. A dark pensée hue spreads over the whole upper surface of the wings, which imparts to it a still more tropical character.

HEMIPTERA.

1. *Heteroptera.*—A small collection of this low order was made, but has not been studied. Thus no special account can be given.

The varied forms occurring in this portion of the collection may justify the conclusion that almost every section of the group of geocorida is represented in this series.

Most prominent on account of their size and vivid colors, is a form of the genus Harpactor? which were frequently caught sticking to the gum which exudes from wounded caoutchouc trees.

The sections of Scutata, Coreida, Lygæina, and Capsina seem to be numerically represented foremost.

2. *Homoptera.*—Of the family of Cicadaria, which must be very extensively distributed through the whole region, only few forms of the genus Cicada were secured.

Their sport, under the circumstances, proved to be rather a difficult task.

DIPTERA.

To Baron Von Osten Sacken, of the imperial Russian legation at Washington, who kindly looked over the specimens of this class, which were collected on the Truandó, we are indebted for the following notice:

Sarcophaga, (1 sp.)
Trypeta, (allied to Trypeta Longipeunnis, Wied.)
Lepiselaga, n. sp., Löw. Lepidotæ, Wied. affin.
Our species much resembles the latter, but is distinct.
Calobata, (2 sp.)
Volucella Obesa, Fabr.
Chrysops, (1 sp.)
Simulium, (1 sp.)
Ocyptera, (1 sp.)
Trupanea, (1 sp.)

[To these we have to add a small species of Pulex, of which myriads have been encountered in temporarily deserted Indian huts and station houses, (Tambos,) so as to render them unfit—at least for white people—to live in.

Of the genus Sarcopsyllum, there is the Nigua of the natives, with which I became personally acquainted while we were making our way along the shores of the Nercua. Some mother must have intrusted me at that time of barefooted traveling with her hopeful progeny, of which I received the first notice about a fortnight afterwards. A slight tickling then made me examine one of my footsoles, from which I dug out in two places one small vesicle of the size of a pea. These vesicles contained each from 40 to 50 well-ripe eggs, which I had thus carried from the Nercua river to the gulf of Urabá.]—(A. S.)

ARACHNIDA.

According to our observations an endless variety must exist on the isthmus. Our collection also contains a considerable number of forms belonging to the following groups: Mygale, Lycosa, Latr.; Salticus, Latr.; Epeira, Walk.

The family of Scorpionida furnished us two distinct species, both dark colored.

Trombidium holosericeum, or some species closely allied to it, which I found also very common all through western Texas, appears to be by no means rare in the low regions of Chocó.

Ixodes counts the much-talked-of Garabata of the natives among its members.

CRUSTACEA.

For the following account on the collected specimens of this order we are indebted to Mr. William Stimpson, who has made Crustaceæ his special study.

The list of genera and species, though small, contains also the description of a new and now second species of the genus Potamocarcinus.

List of Crustaceæ found in the Bay of Cartajena and its vicinity westward.

A.—MARINE. BRACHYURA.

Mitteraculus coronatus, (Stm.)
Mitterax aculeatus, (M. Edw.)
Atergatis lobatus, (Stm.)
Menippe rumphii, (DeH.)
Eriphia gonagra, (M. Edw.)
Collinectes diacanthus, (Stm.)
Gelasimus palustris, (M. Edw.)
Sesarma angustipes, (Dana.)
Hepatus angustatus.

ANOMURA.

Petrolisthes armatus, (Stm.)
Clibanarius sclopetarius, (Stm.)

B.—FRESHWATER.

Petamocarcinus denticulatus, (Stm.)

The following description will serve to distinguish it from P. armatus:

Potamocarcinus denticulatus; carpace plano; obsolete granulato; margine anteriore-laterali 18 denticulato; masillipedum externorum; articulo quarto, vel mero lato, fere quadrato. Carapacis maris, longitud. 0.84, latitud. 1.22 parallel. Hab. In flumine Atrato, Rei Publicæ Novæ Granadæ.

MYRIAPODA.

Scolopendrida.—Of this family four or five different forms have been observed and collected. Among them we also found an old Texian or Mexican acquaintance, in the shape of Sc. heros, measuring more than ten inches in length.

Iulida.—But few forms of this family were observed. Numerically, however, they were found to be very largely represented along the line of survey. In size but few members of the genus Iulus came up

to those seen on the Lower Bravo del Norte, where they seem to be not less common.

CIRRIPEDIA.

Lepadina.—Anatifa striata? This species was observed in almost unlimited numbers, as well in the Antillean as also in the Mexican gulf waters. The floating gulf weed (Sargassum vulgare and S. bacciferum) was frequently fished out overloaded with these singular sea-rovers.

Balanina.—Many forms of this peculiar family have been observed, most of them, however, small. On the Pacific side, upon the Playa Paracuchichí, a large purple specimen was picked up, which, by its affinities, may be referred to Balanus tintinnabulum, (the sea tulip.) It measured one inch in length, with a basal diameter of 0.75 of an inch.

CEPHALAPODA.

Spirulacea.—Specimens of one Spirula (Lam.) were collected on the sea-beach at Cartajena. I hardly can distinguish it from Sp. Peronii.

CEPHALOPHORA.

Of this and the following class quite a number of specimens were collected, respectively, on both termini of our line of travel.

The material brought home, however, did not prove to be sufficient for identification of all the species. We here subjoin an enumeration of species alphabetically arranged:

A.—Atlantic specimens obtained at Cartajena and at Turbó, in the Gulf of Urabá.

Bulla fisurella.
Cerithium varians.
Chiton, sp?
Conus flammeus.
Conus, sp?
Crepidula, sp?
Cypræa, 2 or 3 sp.
Dentalium, sp.
Fascicularia Tulipa.
Fisurella picta?
Littorina, sp.
Marginella prunum.
Murex messorius.
Murex, sp?
Natica, sp?
Nerinea, sp?
Nerita meleagris.
Nerita versicolor.

Neritina virginica.
Oliva reticulata.
Orthalinus Zebra.
Polinices mammillaris.
Polinices, sp?
Purpura patula.
Purpura undata.
Pyrula canaliculata.
Pyrula melongena.
Sigaretus, sp?
Solarium granulatum.
Solen caribæum.
Strombus alatus.
Strombus bituberculatus?
Terebra, 2 sp?
Teredo navalis.
Turitella, sp?
Valuto musica.

B.—PACIFICAN SPECIMENS, COLLECTED ON THE PLAYA OF PARACUCHICHÍ AND IN THE TOTUMIA RIVER.

Cassis abbreviata:
Cerithium, sp?
Cerethium, sp?
Crepidula, sp?
Marginella conoidalis.
Neritina latissima?

ACEPHALA.

A.—ATLANTIC SPECIMENS.

Anomalocardia flexuosa.
Arca Noa.
Cardium muricatum.
Corbula, sp?
Dione Dione.
Dione circinata.
Donax, sp?
Imperator, sp?
Modiola, sp?
Omphalius, sp?
Tellina punicea.
Trigonia calicula.
Trivia, sp?
Venus cancellata.
Venus Paphia.
Venus, sp?

B.—PACIFICAN SPECIMENS.

Arca, sp?
Dione, 2 sp?
Donax cælatus.
Donax culminatus.
Donacilla, sp.
Dosinia Annæ.
Dosinia Dunkeri.
Lucina, sp?
Mactra, sp?
Pecten, sp?
Pectunculus, sp?
Strigella carnaria, var. plicata.
Strigella piscium.
Trigonia radiata, var. Hindsii.
Trigonia planulata, var.
Venus Amathusia.
Venus Paphia.
Venus neglecta.
Venus, sp?
Vermetus lumbricalis.

HELMINTHIA.

One species of Tænia was obtained from the entrails of a white faced monkey, (Cebus leucocephalus,) as also a whole lot of Filariæ were taken from the inside of a large belted kingfisher.

Both species, preserved in alcohol, are deposited in the Smithsonian Institution.

HOLOTHURIDA.

A true Holoturia was added to our collections at Cartajena.

ECHININA.

Animals of this family were found to abound in the salt water lagoons and ditches about Cartajena. One or two species of Cidarida occur in the collection, which also contains two forms of Asterina.

ASTERINA.

One species, orange colored, with a slimy slippery surface, may be allied to Asteropecten aurantiacus; the other, much larger form, according to Mr. Stimpson, seems to be identical with Oreaster gigas.

OPHIURIDA.

One form, very much like Ophiothrix fragilis, was caught in the harbor of Cartajena.

SERTULARINA.

A very small delicate form of a species of Sertularia was found to cover the bottoms of boats, after a few months' floating in the tropical waters of Cartajena.

The bay of this place also is characterized by the abundance of corals of various descriptions. These furnish to the people there an excellent building and paving material. The most common seems to be a species of Mæandrina of the family.

MADREPORINA.

In some shallow places of the bay another species seems to abound, which is very closely allied to Pavonia cristata if not identical with it.

PORIFERA.

Not less interesting, and by their habitat intimately connected with the coralline life of the salt waters of Cartajena, are the richly developed Spongiaceæ. Various members of this Phytozoic family came to our observation, by which we were able to recognize two distinct forms.

With the sponges, our series of collected, or otherwise observed "Invertebratæ," closes. May some future traveler through these regions be favored with better collecting facilities than we have been, that science in general may be furnished with material more complete than that we have been able to bring home.

A. SCHOTT.

XVIII.

EXPLANATORY REPORT TO TABLES 1, 2, 3, AND 4, COMPRISING A COMPILATION OF RESULTS OF GEODETIC SURVEY.

The importance of the problem of a ship canal, without locks, to connect the Atlantic and Pacific oceans, which has given rise to the Atrato Expedition, and the necessity of removing any doubts arising from misrepresentations of the labors of the party in charge of the geodetic survey, render it more urgent than on other occasions of similar kind, to discuss briefly the manner of computing from the original field notes the tables forming the base of the maps, profiles, and estimates which accompany Lieutenant Michler's Report of this Expedition, and to set forth the considerations under which any corrections have been applied to these field notes.

Circumstances did not allow a thorough investigation of this important matter; and even a verification of the results of Captain Kennish's bold reconnoissance across the Andes, to effect which Lieutenant Michler was instructed, has been obtained only by the most faithful devotion of all concerned, in spite of the many dangers of the tropical wilderness.

The party succeeded, however, in making a thorough survey of the route in question, and no observations have been omitted which were necessary for preparing the maps, profiles, and estimates.

Lieutenant Michler has already mentioned that the short space of time allowed for the survey, and the nature of the country, presenting to the surveyor all the obstacles in which a tropical forest abounds, prevented the measurement of the distances between the stations by chain or rod. The only way of obtaining the length of the sight lines was to determine the same by means of distance meters fixed in the tubes of the instruments used.

In the instruments used between the village of Sucio, on the Atrato, and the Pacific ocean, the distance meter consisted of two or three fixed horizontal wires, including an angle of sight constant for any distance except very short ones, which require a shorter focus, thereby slightly increasing this angle.

Vertical divided rods were used for taking the distance readings.

The tables of these readings and the corresponding distances show that the proportion between reading and distance is constant, except for very short distances, but these have been avoided.

The following are the tables of readings and distances for the instruments used on the overland route, prepared with the aid of actual measurement.

Tables of readings and distances for the instruments used on the overland route, obtained by actual measurement.

Readings between the two extreme wires of compass level No. 5.

Distance.	Reading.	Distance.	Reading.	Distance.	Reading.	Distance.	Reading.
50	0.15	420	1.32	790	2.51	1150	3.66
60	0.18	430	1.36	800	2.54	1160	3.69
70	0.21	440	1.39	810	2.57	1170	3.72
80	0.24	450	1.42	820	2.60	1180	3.76
90	0.27	460	1.45	830	2.64	1190	3.79
100	0.305	470	1.48	840	2.67	1200	3.82
110	0.34	480	1.52	850	2.70	1210	3.85
120	0.37	490	1.55	860	2.73	1220	3.88
130	0.40	500	1.58	870	2.76	1230	3.92
140	0.43	510	1.61	880	2.80	1240	3.95
150	0.465	520	1.64	890	2.83	1250	3.98
160	0.50	530	1.68	900	2.86	1260	4.01
170	0.53	540	1.71	910	2.89	1270	4.04
180	0.56	550	1.74	920	2.92	1280	4.08
190	0.59	560	1.77	930	2.96	1290	4.11
200	0.625	570	1.80	940	2.99	1300	4.14
210	0.66	580	1.84	950	3.02	1310	4.17
220	0.69	590	1.87	960	3.05	1320	4.20
230	0.72	600	1.90	970	3.08	1330	4.24
240	0.75	610	1.93	980	3.12	1340	4.27
250	0.78	620	1.96	990	3.15	1350	4.30
260	0.81	630	2.00	1000	3.18	1360	4.33
270	0.85	640	2.03	1010	3.21	1370	4.36
280	0.88	650	2.06	1020	3.24	1380	4.40
290	0.91	660	2.09	1030	3.28	1390	4.43
300	0.94	670	2.12	1040	3.31	1400	4.46
310	0.97	680	2.16	1050	3.34	1410	4.49
320	1.00	690	2.19	1060	3.37	1420	4.52
330	1.04	700	2.22	1070	3.40	1430	4.56
340	1.07	710	2.25	1080	3.44	1440	4.59
350	1.10	720	2.28	1090	3.47	1450	4.62
360	1.13	730	2.32	1100	3.50	1460	4.65
370	1.16	740	2.35	1110	3.53	1470	4.68
380	1.20	750	2.38	1120	3.56	1480	4.72
390	1.23	760	2.41	1130	3.60	1490	4.75
400	1.26	770	2.44	1140	3.63	1500	4.78
410	1.29	780	2.48				

Readings between the middle and lower wires of level No. 6.

Distance.	Reading.	Distance.	Reading.	Distance.	Reading.	Distance.	Reading
50	0.14	160	0.46	270	0.77	380	1.09
60	0.17	170	0.49	280	0.80	390	1.115
70	0.20	180	0.515	290	0.83	400	1.14
80	0.23	190	0.54	300	0.86	410	1.17
90	0.26	200	0.57	310	0.89	420	1.20
100	0.29	210	0.60	320	0.915	430	1.23
110	0.315	220	0.63	330	0.94	440	1.26
120	0.34	230	0.66	340	0.97	450	1.29
130	0.37	240	0.69	350	1.00	460	1.315
140	0.40	250	0.715	360	1.03	470	1.34
150	0.43	260	0.74	370	1.06	480	1.37

Table of readings and distances—Continued.

Readings between the middle and lower wires of level No. 6—Continued.

Distance.	Reading.	Distance.	Reading.	Distance.	Reading.	Distance.	Reading.
490	1.40	770	2.20	1040	2.97	1310	3.74
500	1.43	780	2.23	1050	3.00	1320	3.77
510	1.46	790	2.26	1060	3.03	1330	3.80
520	1.49	800	2.285	1070	3.06	1340	3.83
530	1.515	810	2.31	1080	3.085	1350	3.86
540	1.54	820	2.34	1090	3.11	1360	3.885
550	1.57	830	2.37	1100	3.14	1370	3.91
560	1.60	840	2.40	1110	3.17	1380	3.94
570	1.63	850	2.43	1120	3.20	1390	3.97
580	1.66	860	2.46	1130	3.23	1400	4.00
590	1.69	870	2.485	1140	3.26	1410	4.03
600	1.715	880	2.51	1150	3.285	1420	4.06
610	1.74	890	2.54	1160	3.31	1430	4.085
620	1.77	900	2.57	1170	3.34	1440	4.11
630	1.80	910	2.60	1180	3.37	1450	4.14
640	1.83	920	2.63	1190	3.40	1460	4.17
650	1.86	930	2.66	1200	3.43	1470	4.20
660	1.89	940	2.685	1210	3.46	1480	4.23
670	1.915	950	2.71	1220	3.485	1490	4.26
680	1.94	960	2.74	1230	3.51	1500	4.28
690	1.97	970	2.77	1240	3.54	1550	4.43
700	2.00	980	2.80	1250	3.57	1600	4.57
710	2.03	990	2.83	1260	3.60	1650	4.71
720	2.06	1000	2.86	1270	3.63	1700	4.85
730	2.09	1010	2.885	1280	3.66	1800	5.14
740	2.115	1020	2.91	1290	3.685	1900	5.43
750	2.14	1030	2.94	1300	3.71	2000	5.71
760	2.17						

Readings between the upper and middle wires of theodolite No. 1.

Distance.	Reading.	Distance.	Reading.	Distance.	Reading.	Distance.	Reading.
50	0.40	72	0.57	94	0.74	116	0.915
51	0.41	73	0.58	95	0.75	117	0.92
52	0.42	74	0.59	96	0.76	118	0.93
53	0.42	75	0.595	97	0.77	119	0.94
54	0.43	76	0.60	98	0.775	120	0.95
55	0.44	77	0.61	99	0.78	121	0.95
56	0.45	78	0.62	100	0.79	122	0.96
57	0.455	79	0.63	101	0.80	123	0.97
58	0.46	80	0.63	102	0.81	124	0.98
59	0.47	81	0.64	103	0.81	125	0.985
60	0.48	82	0.65	104	0.82	126	0.99
61	0.49	83	0.66	105	0.83	127	1.00
62	0.49	84	0.67	106	0.84	128	1.01
63	0.50	85	0.67	107	0.845	129	1.02
64	0.51	86	0.68	108	0.85	130	1.02
65	0.52	87	0.69	109	0.86	131	1.03
66	0.525	88	0.70	110	0.87	132	1.04
67	0.53	89	0.705	111	0.88	133	1.05
68	0.54	90	0.71	112	0.88	134	1.055
69	0.55	91	0.72	113	0.89	135	1.06
70	0.56	92	0.73	114	0.90	136	1.07
71	0.56	93	0.74	115	0.91	137	1.08

Table of readings and distances—Continued.

Readings between the upper and middle wires of theodolite No. 1—Continued.

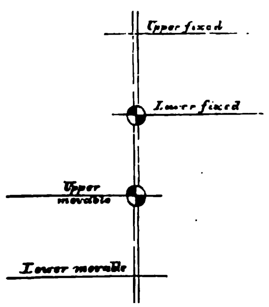
Distance.	Reading.	Distance.	Reading.	Distance.	Reading.	Distance.	Reading.
138	1.09	191	1.50	244	1.91	297	2.32
139	1.09	192	1.51	245	1.92	298	2.33
140	1.10	193	1.51	246	1.925	299	2.335
141	1.11	194	1.52	247	1.93	300	2.34
142	1.12	195	1.53	248	1.94	305	2.38
143	1.125	196	1.54	249	1.95	310	2.42
144	1.13	197	1.545	250	1.96	315	2.46
145	1.14	198	1.55	251	1.96	320	2.50
146	1.15	199	1.56	252	1.97	325	2.54
147	1.16	200	1.57	253	1.98	330	2.575
148	1.16	201	1.58	254	1.99	335	2.61
149	1.17	202	1.58	255	1.995	340	2.65
150	1.18	203	1.59	256	2.00	345	2.69
151	1.19	204	1.60	257	2.01	350	2.73
152	1.195	205	1.61	258	2.02	355	2.77
153	1.20	206	1.615	259	2.03	360	2.81
154	1.21	207	1.62	260	2.03	365	2.85
155	1.22	208	1.63	261	2.04	370	2.88
156	1.23	209	1.64	262	2.05	375	2.92
157	1.23	210	1.65	263	2.06	380	2.96
158	1.24	211	1.65	264	2.065	385	3.00
159	1.25	212	1.66	265	2.07	390	3.04
160	1.26	213	1.67	266	2.08	395	3.08
161	1.265	214	1.68	267	2.09	400	3.12
162	1.27	215	1.685	268	2.10	405	3.155
163	1.28	216	1.69	269	2.10	410	3.19
164	1.29	217	1.70	270	2.11	415	3.23
165	1.30	218	1.71	271	2.12	420	3.27
166	1.30	219	1.72	272	2.13	425	3.31
167	1.31	220	1.72	273	2.135	430	3.35
168	1.32	221	1.73	274	2.14	435	3.39
169	1.33	222	1.74	275	2.15	440	3.43
170	1.335	223	1.75	276	2.16	445	3.465
171	1.34	224	1.75	277	2.165	450	3.50
172	1.35	225	1.76	278	2.17	455	3.54
173	1.36	226	1.77	279	2.18	460	3.58
174	1.37	227	1.78	280	2.19	465	3.62
175	1.37	228	1.785	281	2.20	470	3.66
176	1.38	229	1.79	282	2.20	475	3.70
177	1.39	230	1.80	283	2.21	480	3.735
178	1.40	231	1.81	284	2.22	485	3.77
179	1.405	232	1.82	285	2.23	490	3.81
180	1.41	233	1.82	286	2.235	495	3.85
181	1.42	234	1.83	287	2.24	500	3.89
182	1.43	235	1.84	288	2.25	525	4.08
183	1.44	236	1.85	289	2.26	550	4.28
184	1.44	237	1.855	290	2.27	575	4.47
185	1.45	238	1.86	291	2.27	600	4.66
186	1.46	239	1.87	292	2.28	625	4.86
187	1.47	240	1.88	293	2.29	650	5.05
188	1.475	241	1.89	294	2.30	675	5.24
189	1.48	242	1.89	295	2.30	700	5.44
190	1.49	243	1.90	296	2.31		

The distance table for theodolite No. 1 has been determined for each foot of distance, on account of this instrument being used for the trigonometrical level across the mountain, in which process the difference in level between two stations is dependent on distance. As,

however, no reading could be taken with sufficient accuracy to give the third decimal, the latter has been omitted in the table; and in computing the level, it has been deemed proper not to use fractions of a foot in the determination of distances. These would only be imaginary, as they could not have been observed, and consequently would give an erroneous result, if taken as bases for the computation of the elevations.

The distances contained in the table of true courses and distances (Table No. I) from Sucio to the Pacific ocean, have been inserted according to these tables, no correction being necessary.

The survey of the Atrato river has been conducted on a different plan. The loose condition of the river banks on the greater part of its course, and the long swimming reed grass, covering more than half the width of the river for long distances, and hiding the shore completely, made a survey with firm shore stations impossible. For these reasons the stations had to be established in the small boats in which the party descended the river. The instrument used for ascertaining the distances was the telescope of a Brunner theodolite, with fixed and movable wires, the latter to be adjusted to cover, together with the former, the two end points of a vertical base fixed on a rod by targets. This adjustment was effected by a micrometer attached to the telescope, on which the readings were taken. Two different vertical bases were used in the course of the survey along the river, one of six feet for the river Atrato and the Caño Barbacoas, both of which admit of long sights, and another of three feet in the narrow and crooked Caño Coquito, and the readings were taken after having set the upper movable wire across the lower target, keeping the lower wire fixed to cover the upper target.



The relation between the reading on the micrometer wheel and the corresponding distance is as follows:

Let α be the angle of sight for the vertical base.

a the vertical base.

D the distance of the vertical base.

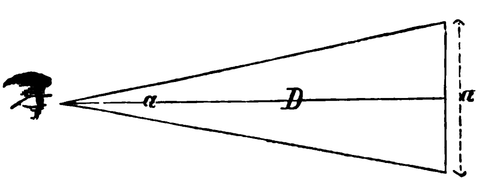
e the distance from the eye to the wire system.

r the immediate relation between the vertical motion of the movable wire and the circular motion of the micrometer wheel, viz:

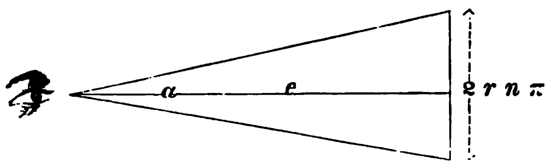
$$2\, r\, \pi = 1 \text{ revolution.}$$

n number of revolutions.

I.



II.



In examining these two figures we find two relations of the angles of sight, one to the distance D and vertical base a (I), and the other to the small distance e and the number of revolutions n:

$$\text{Tang. } \tfrac{1}{2}\, a = \frac{a}{2\,D} \text{ (I), and tang. } \tfrac{1}{2}\, a = \frac{r\,n\,\pi}{e} \text{ (II).}$$

$$\text{Consequently: } D = \frac{a\,e}{2\,n\,r\,\pi}.$$

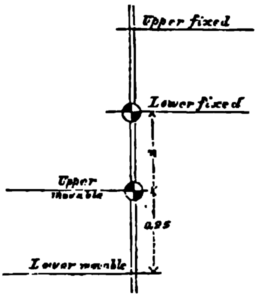
$$\text{Or: } n = \left(\frac{e}{2\,r\,\pi}\right) \cdot \left(\frac{a}{D}\right)$$

The expression e is not invariable, and $\frac{e}{2\,r\,\pi}$, which is $= n\,\frac{D}{a}$, increases gradually for increasing distances, because the focal distance has to be increased for more distant objects. I give here some of the values of $\frac{e}{2\,r\,\pi}$, with the corresponding distances, in order to show how rapidly this value increases for small distances, and how that increase diminishes for greater distances, until at 9,000 feet it is no longer perceptible, even in the first decimal.

Table of $\frac{e}{2\,r\,\pi}$.

D.	$\frac{e}{2\,r\,\pi}$.	D.	$\frac{e}{2\,r\,\pi}$.	D.	$\frac{e}{2\,r\,\pi}$.	D.	$\frac{e}{2\,r\,\pi}$.
200	1316	1000	1415	1800	1457	2900	1476
250	1325	1050	1419	1850	1459	3000	1477
300	1334	1100	1423	1900	1460		
350	1342	1150	1427	1950	1461		
400	1350	1200	1430	2000	1462	3200	1478
450	1357	1250	1433			3400	1479
500	1364	1300	1436			3700	1480
550	1370	1350	1439	2100	1464	4000	1481
600	1376	1400	1441	2200	1466	4400	1482
650	1382	1450	1444	2300	1467	5000	1483
700	1387	1500	1446	2400	1469	6000	1484.0
750	1392	1550	1448	2500	1471	7000	1484.5
800	1397	1600	1450	2600	1472	8000	1484.8
850	1402	1650	1452	2700	1474	9000	1485.0
900	1406	1700	1454	2800	1475	10000	1485.0
950	1411	1750	1456				

The following tables of readings and distances stand in close relation to the above, $\frac{e}{2 r \pi}$ being $= n \frac{D}{a}$, or, as above, $n \frac{e}{2 r \pi} \cdot \frac{a}{D}$. In computing any value of n from the above table of $\frac{e}{2 r \pi}$, an alteration in the formula is necessary, viz:



$$n = \frac{e}{2 r \pi} \cdot \frac{a}{D} - 0.25.$$

The formula, without the insertion of this constant, gives the number of revolutions required for setting the lower movable wire on the lower target, and the lower fixed one on the upper target. By setting both these wires to cover each other, the micrometer wheel is found to stand on zero, ($n = 0$.) For the survey, however, it was found more convenient to observe the upper instead of the lower movable wire; and to these actual observations the following table refers:

Table of distances and readings for Brunner theodolite.

Vertical base, 6 feet.

D.	*n.*	*D.*	*n.*	*D.*	*n.*	*D.*	*n.*
500	16.12	830	9.86	1160	7.10	1490	5.58
510	15.82	840	9.74	1170	7.04	1500	5.54
520	15.53	850	9.63	1180	6.98	1510	5.50
530	15.25	860	9.52	1190	6.92	1520	5.47
540	14.98	870	9.41	1200	6.87	1530	5.43
550	14.72	880	9.30	1210	6.82	1540	5.40
560	14.47	890	9.20	1220	6.76	1550	5.36
570	14.22	900	9.10	1230	6.71	1560	5.33
580	13.98	910	9.00	1240	6.66	1570	5.29
590	13.75	920	8.90	1250	6.61	1580	5.26
600	13.53	930	8.81	1260	6.56	1590	5.23
610	13.32	940	8.72	1270	6.51	1600	5.19
620	13.11	950	8.63	1280	6.46	1610	5.16
630	12.90	960	8.54	1290	6.41	1620	5.13
640	12.70	970	8.46	1300	6.37	1630	5.09
650	12.51	980	8.38	1310	6.33	1640	5.06
660	12.32	990	8.30	1320	6.28	1650	5.03
670	12.14	1000	8.21	1330	6.23	1660	5.00
680	11.97	1010	8.13	1340	6.19	1670	4.97
690	11.80	1020	8.05	1350	6.14	1680	4.94
700	11.64	1030	7.98	1360	6.10	1690	4.91
710	11.48	1040	7.91	1370	6.05	1700	4.88
720	11.33	1050	7.83	1380	6.01	1710	4.85
730	11.18	1060	7.76	1390	5.97	1720	4.82
740	11.03	1070	7.69	1400	5.93	1730	4.79
750	10.89	1080	7.62	1410	5.89	1740	4.77
760	10.75	1090	7.55	1420	5.85	1750	4.74
770	10.61	1100	7.48	1430	5.81	1760	4.72
780	10.48	1110	7.41	1440	5.77	1770	4.69
790	10.35	1120	7.34	1450	5.73	1780	4.66
800	10.22	1130	7.28	1460	5.69	1790	4.64
810	10.10	1140	7.22	1470	5.65	1800	4.61
820	9.98	1150	7.16	1480	5.61	1810	4.59

Distances and readings for Brunner theodolite—Continued.

Vertical base, 6 feet.

D.	n.	D.	n.	D.	n.	D.	n.
1820	4.56	2430	3.38	3040	2.66	4260	1.84
1830	4.54	2440	3.37	3060	2.65	4280	1.83
1840	4.51	2450	3.35	3080	2.63	4300	1.82
1850	4.49	2460	3.34	3100	2.61	4320	1.81
1860	4.46	2470	3.32	3120	2.60	4340	1.80
1870	4.44	2480	3.31	3140	2.58	4360	1.79
1880	4.42	2490	3.29	3160	2.56	4380	1.78
1890	4.39	2500	3.28	3180	2.54	4400	1.77
1900	4.37	2510	3.26	3200	2.53	4420	1.76
1910	4.35	2520	3.25	3220	2.51	4440	1.75
1920	4.32	2530	3.23	3240	2.49	4460	1.74
1930	4.30	2540	3.22	3280	2.48	4480	1.73
1940	4.28	2550	3.20	3280	2.46	4500	1.72
1950	4.26	2560	3.19	3300	2.45	4520	1.72
1960	4.23	2570	3.18	3320	2.43	4540	1.71
1970	4.21	2580	3.16	3340	2.42	4560	1.70
1980	4.19	2590	3.15	3360	2.40	4580	1.69
1990	4.17	2600	3.14	3380	2.39	4600	1.68
2000	4.15	2610	3.12	3400	2.37	4620	1.68
2010	4.13	2620	3.11	3420	2.36	4640	1.67
2020	4.11	2630	3.10	3440	2.34	4660	1.66
2030	4.09	2640	3.09	3460	2.33	4680	1.65
2040	4.07	2650	3.08	3480	2.31	4700	1.64
2050	4.05	2660	3.06	3500	2.30	4720	1.64
2060	4.03	2670	3.05	3520	2.29	4740	1.63
2070	4.01	2680	3.04	3540	2.27	4760	1.62
2080	3.99	2690	3.03	3560	2.26	4780	1.61
2090	3.97	2700	3.02	3530	2.24	4800	1.60
2100	3.95	2710	3.00	3600	2.23	4820	1.60
2110	3.93	2720	2.99	3620	2.22	4840	1.59
2120	3.91	2730	2.98	3640	2.20	4860	1.58
2130	3.89	2740	2.97	3660	2.19	4880	1.57
2140	3.87	2750	2.96	3680	2.17	4900	1.56
2150	3.85	2760	2.95	3700	2.16	4920	1.56
2160	3.83	2770	2.94	3720	2.14	4940	1.55
2170	3.81	2780	2.93	3740	2.13	4960	1.54
2180	3.79	2790	2.92	3760	2.11	4980	1.54
2190	3.77	2800	2.91	3780	2.10	5000	1.53
2200	3.76	2810	2.90	3800	2.09		
2210	3.74	2820	2.89	3820	2.07		
2220	3.72	2830	2.88	3840	2.06	5050	1.515
2230	3.70	2840	2.87	3860	2.05	5100	1.50
2240	3.69	2850	2.86	3880	2.04	5150	1.485
2250	3.67	2860	2.84	3900	2.03	5200	1.47
2260	3.65	2870	2.83	3920	2.01	5250	1.455
2270	3.64	2880	2.82	3940	2.00	5300	1.44
2280	3.62	2890	2.81	3960	1.99	5350	1.425
2290	3.60	2900	2.80	3980	1.98	5400	1.41
2300	3.59	2910	2.79	4000	1.97	5450	1.395
2310	3.57	2920	2.78	4020	1.96	5500	1.38
2320	3.55	2930	2.77	4040	1.95	5550	1.365
2330	3.54	2940	2.76	4060	1.94	5600	1.35
2340	3.52	2950	2.75	4080	1.93	5650	1.335
2350	3.50	2960	2.74	4100	1.92	5700	1.32
2360	3.49	2970	2.73	4120	1.91	5750	1.305
2370	3.47	2980	2.72	4140	1.90	5800	1.29
2380	3.46	2990	2.71	4160	1.89	5850	1.275
2390	3.44	3000	2.70	4180	1.88	5900	1.26
2400	3.43			4200	1.87	5950	1.245
2410	3.41			4220	1.86	6000	1.23
2420	3.40	3020	2.68	4240	1.85	6050	1.22

Distances and readings for Brunner theodolite—Continued.

Vertical base, 6 feet.

D.	n.	D.	n.	D.	n.	D.	n.
6100	1.21	6750	1.07	7600	0.92	8900	0.75
6150	1.195	6800	1.06	7700	0.91	9000	0.74
6200	1.18	6850	1.05	7800	0.89	9100	0.73
6250	1.17	6900	1.04	7900	0.88	9200	0.72
6300	1.16	6950	1.03	8000	0.86	9300	0.71
6350	1.15	7000	1.02	8100	0.85	9400	0.70
6400	1.14			8200	0.84	9500	0.69
6450	1.13			8300	0.82	9600	0.68
6500	1.12	7100	1.00	8400	0.81	9700	0.67
6550	1.11	7200	0.99	8500	0.80	9800	0.66
6600	1.10	7300	0.97	8600	0.78	9900	0.65
6650	1.09	7400	0.95	8700	0.77	10000	0.64
6700	1.08	7500	0.94	8800	0.76		

Vertical base, 3 feet.

200	19.50	620	6.55	1040	3.95	1460	2.84
210	18.62	630	6.45	1050	3.92	1470	2.82
220	17.82	640	6.35	1060	3.88	1480	2.80
230	17.08	650	6.25	1070	3.84	1490	2.78
240	16.38	660	6.16	1080	3.80	1500	2.76
250	15.74	670	6.07	1090	3.77	1510	2.74
260	15.15	680	5.98	1100	3.74	1520	2.72
270	14.61	690	5.90	1110	3.70	1530	2.70
280	14.10	700	5.82	1120	3.67	1540	2.68
290	13.64	710	5.74	1130	3.64	1550	2.67
300	13.20	720	5.66	1140	3.61	1560	2.65
310	12.78	730	5.58	1150	3.58	1570	2.64
320	12.40	740	5.51	1160	3.55	1580	2.62
330	12.13	750	5.44	1170	3.52	1590	2.61
340	11.70	760	5.37	1180	3.49	1600	2.59
350	11.38	770	5.30	1190	3.46	1610	2.58
360	11.08	780	5.23	1200	3.43	1620	2.56
370	10.79	790	5.17	1210	3.40	1630	2.54
380	10.51	800	5.11	1220	3.37	1640	2.53
390	10.25	810	5.05	1230	3.34	1650	2.51
400	10.01	820	4.99	1240	3.32	1660	2.50
410	9.78	830	4.93	1250	3.30	1670	2.48
420	9.55	840	4.87	1260	3.27	1680	2.47
430	9.34	850	4.81	1270	3.24	1690	2.45
440	9.12	860	4.75	1280	3.22	1700	2.44
450	8.92	870	4.70	1290	3.20	1710	2.42
460	8.73	880	4.65	1300	3.18	1720	2.40
470	8.55	890	4.60	1310	3.15	1730	2.39
480	8.37	900	4.55	1320	3.13	1740	2.38
490	8.21	910	4.50	1330	3.11	1750	2.37
500	8.06	920	4.45	1340	3.09	1760	2.35
510	7.91	930	4.40	1350	3.07	1770	2.34
520	7.77	940	4.36	1360	3.04	1780	2.33
530	7.62	950	4.32	1370	3.02	1790	2.32
540	7.49	960	4.27	1380	3.00	1800	2.31
550	7.36	970	4.23	1390	2.98	1810	2.29
560	7.24	980	4.19	1400	2.96	1820	2.28
570	7.11	990	4.15	1410	2.94	1830	2.27
580	6.99	1000	4.11	1420	2.92	1840	2.26
590	6.87	1010	4.07	1430	2.90	1850	2.25
600	6.76	1020	4.03	1440	2.88	1860	2.23
610	6.65	1030	3.99	1450	2.86	1870	2.22

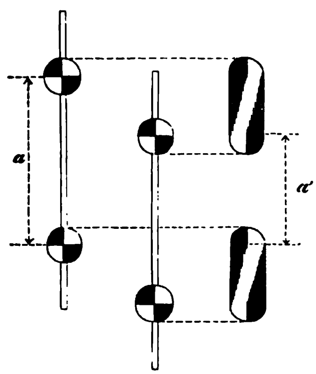
Distances and readings for Brunner theodolite—Continued.

Vertical base, 3 feet.

D.	*n.*	*D.*	*n.*	*D.*	*n.*	*D.*	*n.*
1880	2.21	1920	2.16	1950	2.13	1980	2.10
1890	2.20	1930	2.15	1960	2.12	1990	2.09
1900	2.19	1940	2.14	1970	2.11	2000	2.08
1910	2.17						

All these distance meters were frequently tested during and after the survey, in order to discover any slight change in the wires which might have occurred, but no change was found.

The survey of the Atrato with this distance meter would be just as reliable as that of the overland route, had the stations been on firm ground; but, for reasons above stated, the surveyor had to hold the telescope in his hands during the observation, while sitting in the boat. The chief difficulty arose from the strong northern breeze which prevailed during the whole time the party were descending the river, producing a considerable motion in this large sheet of water. This motion proved a serious obstacle to the accurate adjustment of the wires, especially on those stations which were more exposed to the wind. In consequence of the oscillation of the boat, the distant rod with the targets appeared during the observation as if vibrating up and down, not giving clear images of the targets. In trying to catch the white space on the rod between the targets representing the vertical base a, the observer was apt to read off a distance between the targets shorter than the real one, as represented in the accompanying figure at a'.



The distances taken from the table as corresponding to these erroneous readings are of course found to be too long.

This demonstration is confirmed by the fact that the differences in latitude (obtained by very good astronomical observations) between Sucio, on the upper end of the survey in question, and Pisisi, on the lower end of it, as well as between these places and an intermediate point at the mouth of the Rio Hondo, (Deep river,) are considerably smaller than those derived from the surveying notes. Now, as this survey fortunately has three fixed points, (the two extreme points and an intermediate one,) we are enabled to apply the necessary correction to it according to the above considerations.*

*It is to be remarked that the relative position of the mouth of the Caño Coquito, as well as the shore line of the gulf of Darien, as far as it appears on the lower map of the Atrato river, has been taken from Lieutenant Craven's map of the eastern terminus of the ship canal, only with a little alteration in the immediate vicinity of Pisisi, and taking the latitude of Pisisi, as computed from Lieutenant Michler's observations, as a base.

For this purpose the stations along the whole river have been carefully examined and divided into two classes, viz: 1. Exposed stations, and 2. Protected stations.

Exposed stations.		Protected stations.	
From station —	to station —	From station 32	to station 48
48	54	54	56
56	58	58	60
60	74	74	81
81	87	87	89
89	98	98	100
100	102	102	108
108	112	112	116
116	126	126	128
128	130	130	132
132	134.	134	150
150	152	152	156
156	158	158	169

The first class will be subject to a much greater correction than the latter, the difficulty above stated having been far more serious at those stations where the wind was most violent, and, consequently, the motion of the boat greatest. Further, it will be noticed that the rate of this correction will increase rapidly for greater distances, owing to the circumstance that the error of the angle of sight is not dependent on the distance, but on the oscillation of the boat, while the angle itself diminishes for greater distances.

The angle itself, embracing the vertical base of six feet, is—

For 1,000	feet distance	= 21	minutes,	(approximately.)
2,000	do.	10	do.	do.
3,000	do.	7	do.	do.
4,000	do.	5	do.	do.
5,000	do.	4	do.	do.
6,000	do.	$3\frac{1}{2}$	do.	do.
7,000	do.	3	do.	do.
8,000	do.	$2\frac{2}{3}$	do.	do.
9,000	do.	$2\frac{1}{3}$	do.	do.

found by the relation, $2\ D$ tang. $\frac{1}{2}\ a = 6$, in which D is the distance of the vertical base, and a the corresponding angle of sight.

Having now discovered the different conditions for the necessary corrections to be applied, under these peculiar circumstances, to each station of either of the two classes mentioned, and knowing the exact position, by astronomical determination, of the two extreme points and an intermediate one of the river surveyed, it remains to determine the two errors of the angle of sight committed on the exposed stations and on the protected ones, in such a way as to let the corrected survey coincide with these three points in latitude.

This will be the case by allowing an error of 0.7 minute, or 42 seconds for the first class, and one of $7\frac{6}{10}$ seconds for the second class. The correction of these two errors necessarily reduces all the distances by a properly determined value. These values are expressed most

conveniently for the reduction, as a per centage of the distances originally observed, and are given in the following table:

Table of reduction for the exposed stations.

Distance.	Per cent.	Distance.	Per cent.	Distance.	Per cent.	Distan	Per cent.
100	0.4	2500	7.6	4900	14.2	7300	20.0
200	0.7	2600	7.9	5000	14.4	7400	20.3
300	1.0	2700	8.1	5100	14.7	7500	20.5
400	1.3	2800	8.4	5200	15.0	7600	20.7
500	1.6	2900	8.7	5300	15.2	7700	20.9
600	1.9	3000	9.0	5400	15.5	7800	21.1
700	2.2	3100	9.2	5500	15.7	7900	21.4
800	2.5	3200	9.5	5600	16.0	8000	21.6
900	2.8	3300	9.8	5700	16.2	8100	21.8
1000	3.1	3400	10.1	5800	16.5	8200	22.0
1100	3.5	3500	10.4	5900	16.7	8300	22.3
1200	3.8	3600	10.7	6000	17.0	8400	22.5
1300	4.1	3700	10.9	6100	17.2	8500	22.7
1400	4.4	3800	11.2	6200	17.4	8600	22.9
1500	4.7	3900	11.5	6300	17.7	8700	23.1
1600	5.0	4000	11.8	6400	17.9	8800	23.3
1700	5.3	4100	12.0	6500	18.1	8900	23.6
1800	5.6	4200	12.3	6600	18.4	9000	23.8
1900	5.9	4300	12.6	6700	18.6	9100	24.0
2000	6.1	4400	12.8	6800	18.9	9200	24.2
2100	6.4	4500	13.1	6900	19.1	9300	24.4
2200	6.7	4600	13.4	7000	19.3	9400	24.6
2300	7.0	4700	13.6	7100	19.6		24.8
2400	7.3	4800	13.9	7200	19.8		

Table of reduction for the protected stations.

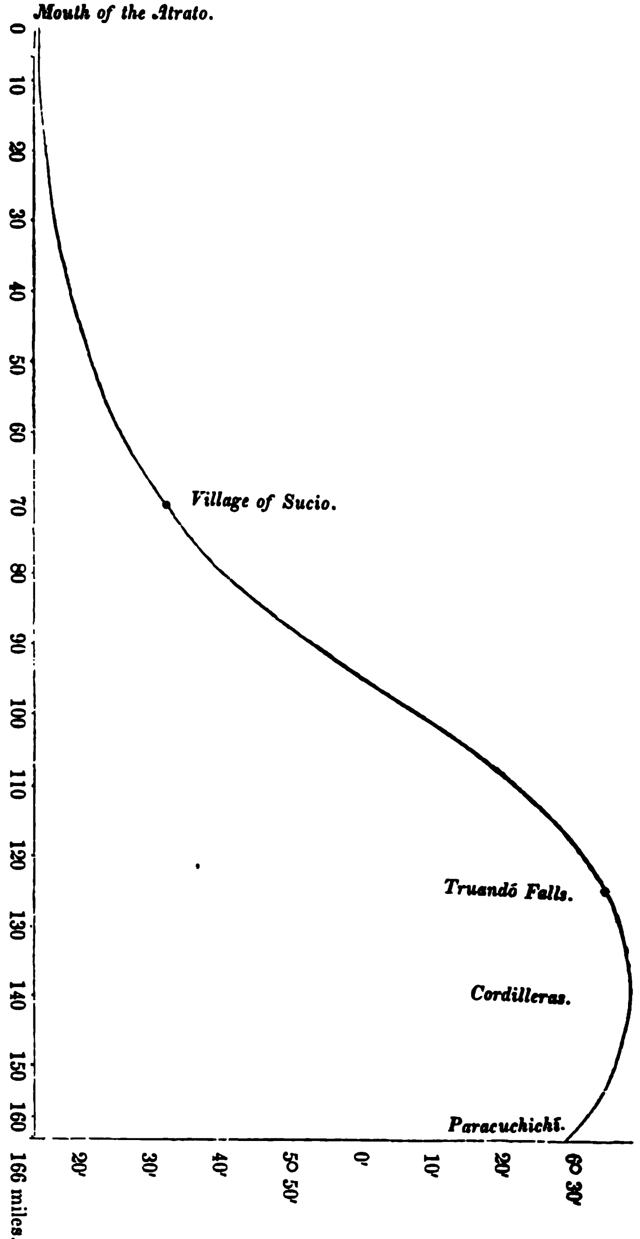
Distance.	Per cent.	Distance.	Per cent.	Distance.	Per cent.	Distance.	Per cent.
	0.0		0.8		1.5		2.1
100		1400		2700		4000	
	0.1		0.8		1.5		2.2
200		1500		2800		4100	
	0.2		0.9		1.6		2.2
300		1600		2900		4200	
	0.2		1.0		1.6		2.3
400		1700		3000		4300	
	0.3		1.0		1.7		2.3
500		1800		3100		4400	
	0.3		1.1		1.7		2.4
600		1900		3200		4500	
	0.4		1.1		1.8		2.4
700		2000		3300		4600	
	0.5		1.2		1.8		2.5
800		2100		3400		4700	
	0.5		1.2		1.9		2.5
900		2200		3500		4800	
	0.6		1.3		1.9		2.6
1000		2300		3600		4900	
	0.6		1.3		2.0		2.6
1100		2400		3700		5000	
	0.7		1.4		2.0		2.7
1200		2500		3800			
	0.7		1.4		2.1		
1300		2600		3900			

The distances contained in the table of true courses and distances (Table No. I) are the immediate results of this reduction.

Concerning this table, it remains to show how the observed magnetic courses have been converted into the true geographical ones.

The magnetic variation is not invariable along the entire length of the surveyed route. The observations made in this respect show an increase of it small along the lower course of the Atrato, but growing more considerable as the route ascends the Truandó, and still increasing until the height of the mountain is reached, after which is decreases slightly towards the shore of the Pacific ocean.

The magnetic observations placed together graphically, represent (by interpolation) a curve of the following shape:



Starting from the smallest magnetic variation observed near the mouth of the Atrato, (5° 21′,) ascending in the above-mentioned w

to the greatest observed variation on the summit of the mountain, (6° 36′,) and slowly descending towards the Pacific shore, terminating there with a variation of 6° 30′.

According to this curve, showing graphically the amount of the magnetic variation at each particular point along the whole line of survey, the correction from the magnetic to the true geographical courses has been made, the results of which are contained in table No. I.

About the table of heights and distances, (Table II,) very little explanation is required. The reasons why the level of the line, carried on without interruption for the whole length of the survey between the village of Sucio on the Atrato, and the settlement of Paracuchichi on the Pacific shore, was abandoned at Sucio, are briefly mentioned in the beginning of this explanatory report, but set forth in detail in Lieutenant Michler's report. In this he discusses also the close coincidence of the altitude of the Atrato at Sucio, as computed from the leveling notes, (assuming, on Colonel Totten's authority, the mean tides of both oceans to be nearly, if not exactly, on the same level,) with the elevation of this point originating from the computation of the measured section of the Atrato and the observed velocity of its current, the latter two agreeing well with the results contained in Captain Kennish's report of his reconnoisance in 1854–55. This computation has been made according to the formula and with the adoption of the constant of friction, pronounced by the most eminent engineers of Europe to give results as near as possible a true solution of a problem like this.

This coincidence is indeed much closer than could have been expected under the trying circumstances which characterized this survey. It shows that the level in question does not reach by far the limit of error allowed for railroad surveys in Germany and Switzerland, countries famous for accuracy in many respects, and especially in surveying and engineering matters.

In order to prove the correctness of this remark, I will quote two paragraphs forming part of the instructions for surveyors and engineers engaged on the Swiss central railroad. These instructions have been literally derived from the instructions existing in the government railroad service of Wurtemberg, which have been adopted by nearly all the States of southern Germany, and by most of the railroad companies in Switzerland.

In the "Instructions for the Chief Surveyor" in the mentioned railroad service, paragraph 13 runs as follows:

"According to the progress of this work, the chief surveyor has to provide the chief engineer with tables of the points of triangulation determined by him. These tables are also to contain the fixed points for detailed survey and for the level. These points, which must consist of objects easily distinguishable and least liable to alteration, such as boundary stones, house sockets, &c., must not be more than 2,000 feet apart, and have to be selected in pairs near each other for the purpose of control. For the difference in altitude between two fixed points, being more than 1,000 feet distant, an error of 0.02 foot is allowed, but the partial errors must counteract themselves in such a way as not to exceed the limit of 0.10 foot in a distance of 16,000 feet."

From the "Instructions for the Division Engineer" in the same railroad service, I give the following extract. In discussing the preliminary work for the railroad, and after having given the instruction that the center of the selected route has to be provided with a leveling peg for every 100 feet, the paragraph 15 runs in the following way:

"After these leveling pegs have been placed, an accurate level of the route has to be taken. The limit of error for the same is 0.02 foot for a distance of 1,000 feet, and 0.01 foot for a distance of 10,000 feet."

Taking no notice of the error allowance for 1,000 feet, which cannot be applied to surveys of considerable length, we see that the chief surveyor obtains for his fixed points (that is, for the points intended to form the base of the railroad level) an error allowance of 0.1 foot for every 3 miles, which makes 3.03 feet for 91 miles, the length of the leveling line between Sucio and the Pacific. The error allowance for the division engineer is still greater, being 0.1 foot for every 10,000 feet, which makes, for 91 miles, or 480,480 feet, an error of 4.8 feet.

In our survey both these error limits have not been reached by far, the altitude of the Atrato at Sucio, as found by the level, being 25.73 feet, and as computed from length, section, and current of the Atrato, 23.9 feet, leaving a difference of 1.83 feet, only six tenths of the allowance for chief surveyors, and not quite four tenths of that for division engineers.

This may be accidental, that is, errors made must have been counteracted by others; and this is also proved by the fact that the difference in question is found to be so much within the allowed error limit, thus compensating the surveyor for the innumerable difficulties and sufferings which accompanied the great responsibility involved in this, the most important part of the much spoken of Atrato Expedition.

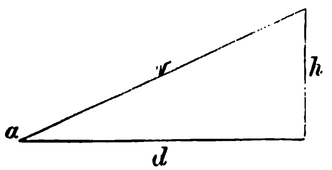
Assuming that the partial errors counterbalance each other on the whole route to the same degree as the mentioned instruction for division engineers in the above mentioned railroad service demands for stations of 10,000 feet distance, the error allowance will decrease in the same progression as from 1,000 to 10,000 feet for the whole length of the survey, namely:

For 1,000 feet, 0.02 foot
For 10,000 feet, 0.1 foot.
For 100,000 feet, 0.5 foot.
For 480,000 feet, 1.2 foot.

By this we find that if the same facilities had existed in this survey as those which the surveyors enjoy in those old settled countries on the other side of the Alantic, the error allowance for the level of a distance of 91 miles (the length of the surveyed line between Sucio and the Pacific) would reach 1.2 foot. From easily perceptible reasons this limit is exceeded on this survey. The excess is 6.3 inches, provided the computed altitude of the Atrato at Sucio is considered to be correct, which may not be the case within several inches. From these considerations it will be an entirely safe conclusion to suppose the real altitude of the Atrato at Sucio to be between 23.9 and 25.73 feet above mean tide.

As already stated by Lieutenant Michler, the level between Sucio and

the Pacific has been obtained by means of a common spirit level, excepting the mountain portion, where the steepness of the route made it advisable to abandon the leveling process by horizontal lines of sight, and to resort to trigonometrical leveling; that is, to obtain the differences of the stations in altitude by the measurement of the angles of elevation or depression, which, together with the distance, give this difference by the following relations:



$$h = v \sin. a.$$

$$d = v \cos. a.$$

h being the difference in altitude; *d* the horizontal distance between the stations; *v* the diagonal distance derived from the table of readings and distances for theodolite No. 1; *a*, the observed angle of elevation or depression. It must be remarked that, in order to obtain the most accurate readings of distance for the duration of the trigonometrical leveling, which makes the difference of height directly dependent on the distance, the rodman was provided with a rectangle, one limb of which he had to put against the rod and move the top of the latter forward or backward until the other limb pointed exactly to the instrument with which the reading was taken, so that the rod was always rectangular to the line of sight—a *conditio sine qua non* for the correctness of the above relations.

The elevation of the instrumental focus was supposed to be invariably 4′ 3″ above the ground, and the same height assumed likewise on the rod as the center between elevation and depression. Although this height must have been in many cases only approximate, still the error was of no consequence, as at each station the line of level, whether raised or lowered by the back sight, was again brought exactly on the same height by the fore sight, the error being thereby completely counterbalanced.

The table of corrections from apparent to true level needs no comment. Very few of the sight lines were of sufficient length to need considerable correction on account of the curvature of the earth; and in addition to this, the foresight is always counteracting the back sight in this respect. The entire amount of this correction is still inside of 7 inches, so that this table is only valuable as an additional element in the thorough investigation which this matter deserves.

JOHN DE LA CAMP.

XIX *a.*

REPORT OF W. H. W. CAMPBELL, METEOROLOGIST, WITH ACCOMPANYING BAROMETRICAL AND METEOROLOGICAL TABLES AND RECORDS.

WASHINGTON, D. C., *April* 4, 1859.

SIR: I have the honor to submit the following report, with accompanying barometrical and meteorological tables and records and computed results of observations, of the duties confided to my charge during the late Interoceanic Ship Canal Survey *via* the Atrato and Truandó rivers, in the province of Chocó, republic of New Granada.

I am, sir, very respectfully, your obedient servant,

W. H. W. CAMPBELL,
Meteorologist of the expedition.

Lieut. N. MICHLER,
Topl. Engs. U. S. A., in charge of topographical party.

BAROMETRIC MEASUREMENT OF ALTITUDES.

The instruments used were made by James Green, of New York city, and consisted of four cistern barometers—Nos. 1258, 1263, 1264, and 1265; with two syphons—Nos. 1362 and 1363; No. 1265 was left on board the schooner in the gulf of Darien, as a standard, and the remainder were taken with the party into the interior. At our first camp on the Truandó, Nos. 1258, 1263, and 1264 were rendered useless by the cracking of their cisterns. This accident occurred during exceedingly damp weather while the instruments were entirely at rest, and was doubtless caused by the expansion of the small blocks of wood to which the cisterns were attached. As we had no means of successfully repairing these instruments, we were obliged to abandon their use for all purposes of measurement, and rely entirely upon the syphons. The standard left upon the coast was, at a later date, rendered useless from the same cause.

CORRECTIONS PREPARATORY TO COMPUTATION.

1. *For temperature of mercury.*—The readings are first reduced to what they would have been at the temperature of 32° Fahr. For this purpose the tables of Professor A. Guyot were used.

2. *For instrumental error.*—The barometer left upon the coast as a standard having been broken, it was found necessary to refer the observations to another instrument which had been transported across the country and constantly used. This barometer (No. 1362) agreed

with the Smithsonian standard at the time of starting, and appeared to read with great regularity during the whole survey, but as no opportunity of comparing it with the Smithsonian standard was afforded after our return, it is not improbable that some inaccuracies may occur in the application of this correction.

3. *For horary oscillations.*—Before preparing the tables for the purpose of ascertaining this correction, a preliminary correction was applied to the hourly readings of those days during which the mercury, from some abnormal cause, was uniformly and steadily rising or falling, except in cases when a rise during one day was followed by an equal fall on the next, or *vice versa*. This correction is represented by the series 0, x, $2x$, $3x$, and cx, being $\frac{1}{24}$ of the difference of the first readings on the two successive days, and is affected by the negative sign when the mercury was rising, and by the positive sign when the contrary was the case. The application of this correction is called "reducing the readings to level," and its value is evident in eliminating an abnormal error which would otherwise affect the table of horary corrections.

After this preparation, the hourly readings were arranged in a table, the false or omitted readings supplied by interpolation, after a careful inspection of curves plotted from the observations, and the hourly and daily means obtained. The difference between the various hourly means and the daily mean, affected with the proper sign, gives the correction for horary oscillation. This correction was calculated for and applied to each instrument separately, as the influence of the barometric wave did not always appear to be the same upon them all, either in respect to time or amplitude of the oscillations.

4. *For abnormal oscillation.*—As no extended series of observations could be made at any one point, it was impossible to obtain this correction further than in the cases referred to above, in the preparation of tables of hourly corrections for normal oscillations.

METHOD OF COMPUTATION.

Barometric reading at the level of the sea.

Since there was no continued series of observations at the level of the sea, in the vicinity of the survey, to which we could obtain access, it was necessary to assume for the reading on the coast the mean of all the observations made there during our stay, embracing a period of over four months, from the early part of November, 1857, to the middle of March, 1858. The means of the readings at the various stations on the line of survey throughout this period, including both those on the Atlantic and those on the Pacific side, the latter of which were nearly coincident in time with a portion of the former, and differed only a few thousandths of an inch from them, from a very regular curve, falling during the months of December, January, and February, and rising again in March. The mean of this curve appears to be lower than the mean of the whole year; but yet, as the observations at the various camps were made during the same months, it would seem the proper basis for the computation.

Readings at the various camps.

The appended example will sufficiently illustrate the method of preparing these readings for computation.

Temperature.

In all cases the mean temperature of the place, as nearly as it could be ascertained, was used. This was obtained by taking the mean of the readings at 9, a. m., and 2 and 9, p. m.

Example.

Computation for determining the height of a station on the dividing ridge of the Cordilleras:

Readings of the barometer.

Date.	Hour.	Number of barometer.	Reading of barometer.	Attached thermometer.	Detached thermometer.
1858.			°	°	°
February 11.......	8.30, A. M.	1362	29.072	74	73
Do...............	8.30, A. M.	1363	29.068	73	73
Do...............	9.00, A. M.	1362	29.073	75.25	74
Do...............	9.00, A. M.	1363	29.068	74	74
Do...............	9.30, A. M.	1362	29.075	76	74.9
Do...............	9.30, A. M.	1363	29.063	75	74.9
Do...............	10.00, A. M.	1362	29.074	77	76
Do...............	10.00, A. M.	1363	29.064	76.5	76

Table showing the corrections applied.

February 11, 1858.	8.30, A. M.		9, A. M.		9.30, A. M.		10, A. M.	
	1362.	1363.	1362.	1333.	1362.	1363.	1362.	1363.
Barometric reading	29.072	29.068	29.073	29.068	29.075	29.063	29.074	29.064
Corerction for temperature	—.118	—.115	—.121	—.118	—.123	—.120	—.126	—.124
Instrumental error	.000	+.005	.000	.005	.000	+.005	.000	+.005
Hororary oscillation.......	—.036	—.034	—.039	—.039	—.041	—.040	—.042	—.040
Corrected reading...............	28.918	28.924	28.913	28.916	28.911	28.908	28.906	28.905

Mean of the corrected readings = 28.913.
Mean daily temperature, about 75.2°, Fah.

Computation by Loomis's tables.

Upper station:
Barometer, h' 28.913
Temperature, t'.... 75.2°

Lower station:
Barometer, H 29.874
Temperature, t .... 80°

Part I gives, { for H	27499.7
{ for h'	26790.5
First approximate altitude, a	854.2
$\frac{a}{900}(t' + t' - 64) = \frac{854.2}{900} \times 91.2$	86.5
Second approximate altitude, A.........	940.7
Part III gives, for A and L, (about 70).......	2.3
Part IV gives, for A................................	2.3
	945.3
Mean height of lower station above mean tide	5.2
	950.5
	2.0
Height of zero of barometer above upper station, feet..	948.5

Table of data used in computing the various heights with the results as compared with the heights obtained by the level.

Stations.	Mean reading of barometer.	Mean temperature.	Barometric height.	Height by level.	Difference.
	Inches.	°	*Feet.*	*Feet.*	*Feet.*
Sea coast..	29.874	80	....	....	....
First camp on Truandó........................	29.817	75.4	58.39	44.57	+13.82
Tocame	29.805	76.8	69.6	57.39	12.21
Foot of Saltos....................................	29.759	76.1	122.65	97.5	25.15
Observatory Hill................................	29.663	76.6	207.45	204.95	2.5
Head Salto Grande............................	29.741	75.9	132.3	138.79	− 6.49
Head of Saltos...................................	29.737	75.9	138.1	183.47	45.37
Junction of rivers Nercua and Truandó...	29.674	77	192.5	192.6	+ 0.44
Tambo..	29.607	77	260.92	264.4	− 3.48
First ridge west of Rio Nercua............	28.815	75.2	1,046.45	....	....
*Log crossing on Rio Hingadór. No. 1362	29.053	75.2	809.42	791.23	+18.19
			Mean 879.9		
No. 1363	28.912	75.2	949.94	....	....
Camp on Hingadór............................	29.074	75.2	788.6	814.32	−25.72
†Dividing ridge.................................	28.913	75.2	948.5	947.44	+ 1.06
Rio Chupepe	29.631	75.2	240.24	241.35	− 1.11
Rio Totumia, below Dos Bocas............	29.837	75.2	40.6	45.3	5.24

*At this station the difference in the readings of the barometers was so great that the height was computed from the mean of the readings of each instrument separately. In other cases the united mean of both was used. The height given in the table was computed from the readings of the barometer which was used as a standard.

† Example given before.

TABLES FOR OBTAINING THE CORRECTIONS FOR HORARY OSCILLATION.

Turbo, Gulf of Darien, Syphon Barometer, No. 1362, (*Green, N. Y.*)

Data from which was deduced the table of corrections for horary oscillation.

Date.	6, A. M.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.	1, P. M.
1857.								
December 5...........	29.914	29.927	29.944	29.945	29.948	*29.942	29.933	29.912
December 6...........	29.909	29.927′	29.936′	29.937′	29.945′	29.937′	29.939′	29.911′
Hourly mean.........	29.912	29.927	29.940	29.941	20.947	29.940	29.936	29.912
Grand mean..........	29.909	29.909	29.909	29.909	29.909	29.909	20.909	29.909
Horary correction.....	—.003	—.018	—.031	—.032	—.038	—.031	—.027	—.003

Date.	2, P. M.	3, P. M.	4, P. M.	5, P. M.	6, P. M.	7, P. M.	8, P. M.	9, P. M.
1857.								
December 5...........	29.875	29.866	29.848	*29.850	29.871	29.882	29.901	29.952
December 6...........	29.905′	29.889′	29.874′	29.874′	29.888′	*29.892′	*29.895′	*29.909′
Hourly mean.........	29.890	29.878	29.861	29.862	29.880	29.887	29.898	29.931
Grand mean..........	29.909	29.909	29.909	29.909	29.909	29.909	29.909	29.909
Horary correction.....	+.019	+.031	+.048	+.047	+.029	+.022	+.011	—.022

NOTES.—The barometric readings have been reduced to what they would have been at the temperature of 32° Fahrenheit.
The sign * denotes that the readings so marked have been supplied by interpolation, on account of omitted or false readings.
The readings marked ′ have been "reduced to level."

Turbo, Syphon Barometer, No. 1363, (*Green, N. Y.*)

Data for deducing the table of corrections for horary oscillation.

Date.	6, A. M.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.	1, P. M.
1857.								
December 5............	29.904	29.913	29.928	29.941	29.959	*29.946	29.935	29.920
December 6............	29.902	29.910′	29.941′	29.943′	29.943′	29.939′	29.931′	29.900
Hourly mean..........	29.903	29.912	29.935	29.942	29.951	29.943	29.933	29.910
Grand mean	29.903	29.903	29.903	29.903	29.903	29.903	29.903	29.903
Horary correction......	.000	—.009	—.032	—.039	—.048	—.040	—.030	—.007

Date.	2, P. M.	3, P. M.	4, P. M.	5, P. M.	6, P. M.	7, P. M.	8, P. M.	9, P. M.
1857.								
December 5............	29.881	29.860	29.848	*29.847	29.862	29.875	29.922	29.944
December 6............	29.892′	29.876′	29.849′	29.852′	29.865′	*29.870	*29.882′	*29.898
Hourly mean...........	29.887	29.868	29.849	29.850	29.864	29.873	29.902	29.921
Grand mean...........	29.903	29.903	29.903	29,903	29.903	29.903	29.903	29.903
Horary correction.....	+.016	+.035	+.054	+.053	+.039	+.030	+.001	—.018

NOTES.—Readings reduced to temperature 32° Fahrenheit.
Readings marked * are interpolated.
Readings marked ′ are "reduced to level."

Turbo, Cistern Barometer, No. 1258, (*Green, N. Y.*)

Data for deducing the table of corrections for horary oscillation.

Date.	6, A. M.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.	1, P. M.
1857.								
December 5...........	29.907	29.932	29.959	29.966	29.952	*29.943	29.934	29.901
December 6...........	29.904	29.937′	29.948′	29.949′	29.952′	29.945′	29.926′	29.890′
Hourly mean..........	29.906	29.935	29.954	29.958	29.952	29.944	29.930	29.896
Grand mean..........	29.907	29.907	29 907	29.907	29.907	29.907	29.907	29.907
Horary correction.....	+.001	—.028	—.047	—.051	—.045	—.037	—.023	+.011
Date.	**2, P. M.**	**3, P. M.**	**4, P. M.**	**5, P. M.**	**6, P. M.**	**7, P. M.**	**8, P. M.**	**9, P. M.**
1857.								
December 5...........	29.867	29.846	29.843	*29.846	29.868	29.898	29.924	29.932
December 6...........	29.868′	29.857′	29.852′	29.859	29.875′	*29.888′	*29.901′	29.913
Hourly mean..........	29.868	29.852	29.848	29.853	29.872	29.893	29.913	29.923
Grand mean..........	29.907	29.907	29.907	29.907	29.907	29.907	29.907	29.907
Horary correction....	+.039	+.055	+.059	+.054	+.035	+.014	—.006	—.016

NOTES.—Readings all reduced to temperature 32° Fahrenheit.
Readings marked * interpolated.
Readings marked ′ "reduced to level."

Turbo, Cistern Barometer, No. 1265, (*Green, N. Y.*)

Data for deducing the table of corrections for horary oscillation.

Date.	6, A. M.	7, A. M.	8. A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.	1, P. M.
1857.								
December 5...........	29.901	29.928	29.956	29.961	29.943	*29.937	29.932	29.899
December 6...........	29.901	29.933′	29.947′	29.944′	29.949′	29.941′	29.918	29.884′
Hourly mean..........	29.901	29.931	29.952	29.953	29.946	29.939	29.925	29.892
Grand mean..........	29.903	29.903	29.903	29.903	29.903	29.903	29.903	29.903
Horary correction.....	+.002	—.028	—.049	—.050	—.043	—.036	—.022	+.011
Date.	**2, P. M.**	**3, P. M.**	**4, P. M.**	**5, P. M.**	**6, P. M.**	**7, P. M.**	**8, P. M.**	**9, P. M.**
1857.								
December 5...........	29.866	29.842	29.840	*29.841	29.871	29.895	29.922	29.932
December 6...........	29.868′	29.853′	29.847′	29.857′	29.869′	*29.885′	*29.901′	29.914′
Hourly mean..........	29.867	29.848	29.844	29.849	29.870	29.890	29.912	29.923
Grand mean..........	29.903	29.903	29.903	29.903	29.903	29.903	29.903	29.903
Horary correction.....	+.036	+.055	+.059	+.054	+.033	+.013	—.009	— 020

NOTES.—Readings all reduced to temperature 32° Fahrenheit.
Readings marked * interpolated.
Readings marked ′ "reduced to level."

Turbo and other stations on Gulf of Darien. Cistern Barometer, No 1265, (Green, N. Y.)

Data for deducing a table of corrections for horary oscillation.

Date.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.
1857.						
December 19	29.839	29.897	29.881	29.885	29.868	29.852
December 26	29.870	29.859	29.891	29.918	29.924	29.913
1858.						
January 2	29.877	29.865	29.903	29.937	29.910	29.893
January 9	29.858	29.886	29.894	29.898	29.891	29.863
January 16	29.852	29.881	29.912	29.895	29.881	29.886
January 23	*29.898	*29.911	29.937	29.920	29.917	29.893
Hourly mean	29.866	29.883	29.903	29.909	29.898	29.880
Grand mean	29.852	29.852	29.852	29.852	29.852	29.852
Horary correction	—.014	—.031	—.051	—.057	—.046	—.028

Date.	1, P. M.	2, P. M.	3, P. M.	4, P. M.	5, P. M.	6, P. M.
1857.						
December 19	29.818	29.789	29.772	29.764	29.758	29.811
December 26	29.874	29.843	29.813	29.787	29.796	29.803
1858.						
January 2	29.852	29.838	29.813	29.794	29.794	29.811
January 9	29.831	*29.816	*29.800	29.790	29.786	29.800
January 16	29.849	29.829	29.812	*29.795	*29.794	*29.813
January 23	29.882	29.851	29.845	29.831	29.829	29.841
Hourly mean	29.851	29.828	29.809	29.794	29.793	29.813
Grand mean	29.852	29.852	29.852	29.852	29.852	29.852
Horary correction	+.001	+.024	+.043	+.058	+.059	+.039

NOTES.—Readings reduced to temperature of 32° Fahrenheit. Readings marked * interpolated.

First Camp on the Rio Truando, N. Granada. Syphon Bar., No. 1362.

Data for deducing a table of corrections for horary oscillation.

Date.	6, A. M.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.	1, P. M.
1857.								
December 27	*29.804	29.820	29.838	29.856	29.857	29.851	29.843	29.833
December 28	29.809	29.821	29.853	29.860	29·856	29.852	29.834	29.819
1858.								
January 2	29.836	29.873	29.880′	29.885′	29.891′	29.878′	*29.840′	29.827
Hourly mean	29.816	29.838	29.857	29.867	29.868	29.860	29.839	29.826
Grand mean	29.824	29.824	29.824	29.824	29.824	29.824	29.824	29.824
Horary correction	.008	—.014	—.033	—.043	—.044	—.036	—.015	—.002

Date.	2, P. M.	3, P. M.	4, P. M.	5, P. M.	6, P. M.	7, P. M.	8, P. M.	9, P. M.
1857.								
December 27	29.805	29.797	29.791	29.793	29.802	*29.812	29.820	29.822
December 28	29.797	29.781	29.775	29.777	29.780	29.785	29.802	29.812
1858.								
January 2	*29.803′	29.791′	29.787′	29.790′	29.800′	29.817′	29.828′	29.841′
Hourly mean	29.802	29.790	29.784	29.787	29.794	29.805	29.817	29.825
Grand mean	29.824	29.824	29.824	29.824	29.824	29.824	29.824	29.824
Horary correction	+.022	+.034	+.040	+.037	+.030	+.019	+.007	—.001

NOTES—Readings reduced to temperature of 32° Fahrenheit. Readings marked * interpolated.
Readings marked ′ "reduced to level."

First Camp on the Truando. Syphon Barometer, No. 1363.

Data for deducing a table of corrections for horary oscillation.

Date.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.	1, P. M.	2, P. M.
1857.								
December 27..........	29.850	29.865	29.872	29.884	29.877	29.861	29.847	29.800
December 28..........	29.844′	29.864′	29.867′	29.871′	29.861′	29.844′	*29.821′	29.795′
1858.								
January 2.............	29.838	29.849	29.849	29.852	29.846	*29.830	29.810	*29.788
Hourly mean..........	29.844	29.859	29.863	29.869	29.861	29.845	29.826	29.794
Grand mean...........	29.822	29.822	29.822	29.822	29.822	29.822	29.822	29.822
Horary correction.....	—.022	—.037	—.041	—.047	—.039	—.023	—.004	+.028

Date.	3, P. M.	4, P. M.	5, P. M.	6, P. M.	7, P. M.	8, P. M.	9, P. M.
1857.							
December 27..........	29.790	29.785	29.783	29.788	29.804	29.836	29.847
December 28..........	29.786′	29.783′	29.782′	29.789′	29.797′	29.824′	29.835′
1858.							
January 2.............	29.775	29.763	29.760	29.779	29.793	29.805	29.819
Hourly mean..........	29.784	29.777	29.775	29.785	29.798	29.822	29.834
Grand mean...........	29.822	29.822	29.822	29.822	29.822	29.822	29.822
Horary correction.....	+.038	+.045	+.047	+.037	+.024	.000	—.012

NOTES.—Readings reduced to temperature of 32° Fahrenheit.
Readings marked * interpolated.
Readings marked ′ "reduced to level."

First Camp on the Truando. Cistern Barometer, No. 1258.

Data for deducing a table of corrections for horary oscillation.

Date.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12. M.	1, P. M.	2, P. M.
1857.								
December 26..........	29.854	29.889	29.901	29.911	29.903	29.872	29.818	29.799
December 27..........	29.850	29.885	29.894	29.894	29.881	29.855	29.830	29.798
December 28..........	29.848′	29.882′	29.883′	29.881′	29.869′	29.837′	29.808′	29.730′
1858.								
January 2.............	29.854	29.872	29.875	29.869	29.847	*29.810	29.787	29.763
Hourly mean..........	29.851	29.882	29.888	29.889	29.875	29.844	29.811	29.788
Grand mean...........	29.823	29.823	29.823	29.823	29.823	29.823	29.823	29.823
Horary correction.....	—.038	—.059	—.065	—.066	—.052	—.021	+.012	+.035

Date.	3, P. M.	4, P. M.	5, P. M.	6. P. M.	7, P. M.	9, P. M.	9, P. M.
1857.							
December 26..........	29.775	29.760	29.763	29.768	29.787	29.799	29.822
December 27..........	29.777	29.769	29.774	29.778	29.805	29.814	29.829
December 28..........	29.766′	29.776′	29.780′	29.784′	29.791′	29.824′	29.843′
1858.							
January 2.............	29.752	29.746	29.754	29.772	29.788	29.812	29.838
Hourly mean..........	29.770	29.763	29.768	29.776	29.793	29.812	29.833
Grand mean...........	29.823	29.823	29.823	29.823	29.823	29.823	29.823
Horary correction.....	+.053	+.060	+.055	+.047	+.030	+.011	+.010

NOTES.—Readings reduced to temperature of 32° Fahrenheit.
Readings marked * interpolated.
Readings marked ′ "reduced to level."

First camp on the Truandó, Cistern Barometer, No. 1264.

Data for deducing a table of corrections for horary oscillation.

Date.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.	1, P. M.	2, P. M.
1857.								
December 27..........	29.841	29.880	29.886	29.888	29.874	29.852	29.823	29.793
December 28..........	29.843′	29.879′	29.880′	29.877′	29.862′	29.830′	29.793′	29.782′
Hourly mean	29.842	29.880	29.883	29.883	29.868	29.841	29.808	29.788
Grand mean	29.824	29.824	29.824	29.824	29.824	29.824	29.824	29.824
Horary correction	—.018	—.056	—.059	—.059	—.041	—.017	+.016	+.036

Date.	3, P. M.	4, P. M.	5, P. M.	6, P. M.	7, P. M.	8, P. M.	9, P. M.
1857.							
December 27..........	29.782	29.777	29.778	29.789	29.798	29.816	29.832
December 28..........	29.775′	29.772′	29.777′	29.780′	29.786′	29.819′	29.834′
Hourly mean.........	29.779	29.775	29.778	29.785	29.792	29.818	29.833
Grand mean	29.824	29.824	29.824	29.824	29.824	29.824	29.824
Horary correction.....	.045	.049	.046	.039	.032	+.006	—.009

NOTES.—Readings reduced to temperature 32° Fahrenheit.
Readings marked ′ "reduced to level."
Readings marked * interpolated.

Tocame, Rio Truandó, New Granada, Syphon Barometer, No. 1362.

Data for deducing a table of corrections for horary oscillation.

Date.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.	1, P. M.	2, P. M.
1858.								
January 9.............	29.794′	29.800′	*29.802′	29.802′	29.792′	29.787′	29.766′	29.751′
January 10............	29.830	29.856	29.856	29.861	29.858	29.842	29.815	29.790
Hourly mean...........	29.812	29.828	29.829	29.832	29.825	29.815	29.791	29.771
Grand mean	29.788	29.788	29.788	29.788	29.788	29.788	29.788	29.788
Horary correction.....	—.024	—.040	—.041	—.044	—.037	—.027	—.003	-.017

Date.	3, P. M.	4, P. M.	5, P. M.	6, P. M.	7, P. M.	8, P. M.	9, P. M.
1858.							
January 9.............	29.730′	29.729′	29.737′	*29.740′	29.743′	*29.753′	29.766′
January 10....... .. .	29.772	29.769	29.768	29.769	29.785	29.787	29.804
Hourly mean..........	29.751	29.749	29.753	29.755	29.764	29.770	29.785
Grand mean	29.788	29.788	29.788	29.788	29.788	29.788	29.788
Horary correction.....	.037	.039	.035	.033	.024	.018	.003

NOTES.—Readings reduced to temperature 32° Fahrenheit.
Readings marked * interpolated.
Readings marked ′ "reduced to level."

Tocame, Syphon Barometer, No. 1363.

Data for deducing a table of corrections for horary oscillation.

Date.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.	1, P. M.	2, P. M.
1858.								
January 9............	29.798	29.799′	29.806′	29.811′	29.801′	29.786′	29.775′	29.758′
January 10............	29.821	*29.838	29.855	29.855	29.851	29.839	29.820	29.797
Hourly mean..........	29.810	29.819	29.831	29.833	29.826	29.813	29.788	29.778
Grand mean	29.792	29.792	29 792	29.792	29.792	29.792	29.792	29.792
Horary correction.....	—.018	—.027	—.039	—.041	—.034	—.021	—.006	+.014

Date.	3, P. M.	4, P. M.	5, P. M.	6, P. M.	7, P. M.	8, P. M.	9, P. M.
1858.							
January 9............	29.734′	29.740′	29.744′	29 749′	29.759′	29.767′	29.779′
January 10............	29.772	29.772	29.772	29.773	29.788	29.794	29.809
Hourly mean..........	29.753	29.756	20.758	29.761	29.774	29.781	29.794
Grand mean	29.792	29.792	29.792	29.792	29.792	2,.792	29.792
Horary correction.....	+.039	+.036	+.034	+.031	+.018	+.011	—.002

Notes.—Readings reduced to temperature 32° Fahrenheit.
Readings marked * interpolated.
Readings marked ′ "reduced to level."

Camp at foot of Saltos of Rio Truandó, Syphon Barometer, No. 1363.

Data for deducing a table of corrections for horary oscillation.

Date.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.	1, P. M.	2, P. M.
1858.								
January 16............	29.792	29.806′	29.836′	29.837′	29.806′	29.791′	29.766′	29.749′
January 17............	29.770	29.777′	29.795′	*29.797′	29.779′	29.751′	29.737′	29.718′
Hourly mean..........	29.781	29.792	29.816	29.817	29.793	29.771	29.752	29.734
Grand mean	29.759	29.759	29.759	29.759	29.759	29.759	29 759	29.759
Horary correction.....	—.022	—.033	—.057	—.058	—.034	—.012	+.007	+.025

Date.	3, P. M.	4, P. M.	5, P. M.	6, P. M.	7, P. M.	8, P. M.	9, P. M.
1858.							
January 16............	29.739′	29.745′	29.745′	*29.752′	29.757′	29.767′	29.783′
January 17............	29.699′	29.681′	29.684′	29.693′	29.710′	29.728′	29.752′
Hourly mean	29.719	29.713	29.715	29.723	29.734	29.748	29.768
Grand mean	29.759	29.759	29.759	29.759	29 759	29.759	29.759
Horary correction.....	+.040	+.046	+.044	+.036	+.025	+.011	—.009

Notes.—Readings reduced to temperature 32° Fahrenheit.
Readings marked * interpolated.
Readings marked ′ "reduced to level."

Camp near head of Salto Grande, on the Rio Truandó. Syphon Barometer, No. 1362.

Data for deducing a table of corrections for horary oscillation.

Date.	6.15, A.M.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.	1, P. M.
1858.								
January 29	29.736	29.750	29.765	29.768	29.767	29.766	*29.752	*29.740
January 30	29.746	29.758′	*29.772′	29.789′	29.795′	29.790	29.781′	29.760
Hourly mean	29.741	29.754	29.769	29.779	29.781	29.778	29.767	29.750
Grand mean..........	29.741	29.741	29.741	29.741	29.741	29.741	29.741	29.741
Horary correction.....	.000	—.013	— 028	—.036	—.040	—.037	—.026	—.009

Date.	2, P. M.	3, P. M.	4, P. M.	5, P. M.	6, P. M.	7, P. M.	8, P. M.	9, P. M.
1858.								
January 29	29.727	29.707	*29.703	29.706	29.717	29.727	29.728	29.745
January 30	29.730′	29.708′	29.694′	29.697′	*29.709′	29.709′	29.721′	29.727′
Hourly mean..........	29.729	29.708	29 699	29.702	29.713	29.718	29.725	29.736
Grand mean..........	29.741	29.741	29.741	29.741	29.741	29.741	29.741	29.741
Horary correction.....	+.012	+.033	+0.42	+.039	+.028	+.023	+.016	+.005

NOTES.—Readings reduced to temperature 32° Fahrenheit.
Readings marked * interpolated.
Readings marked ′ "reduced to level."

Camp at head of Salto Grande. Syphon Barometer, No. 1363.

Data for deducing a table of corrections for horary oscillation.

Date.	6.15, A.M.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.	1, P. M.
1858.								
January 29............	29.749	29.762	29.770	29.778	29.775	29.763	*29.760	29.755
January 30............	29.750	29.770′	*29.773′	29.777′	29.779′	29.767′	29.765′	29.754
Hourly mean	29.750	29.766	29.772	29.778	29.777	29.765	29.763	29.755
Grand mean..........	29.749	29.749	29.749	29.749	29.749	99.749	29.749	29.749
Horary correction	—.001	—.017	—.023	—.029	—.028	—.016	—.014	—.006

Date.	2. P. M.	3, P. M.	4. P. M.	5, P. M.	6, P. M.	7, P. M.	8, P. M.	9, P. M.
1858.								
January 29............	29.729	29.708	*29.699	29.702	29.715	29.731	29.734	29.742
January 30........ ...	29.732′	29 710′	29.699′	29.702′	29.714′	29.718′	29.727′	29.737′
Hourly mean	29.731	29.709	29.699	29.702	29.715	29.725	29.731	29.740
Grand mean..........	29.749	29.749	29.749	29.749	29.749	29.749	29.749	29.749
Horary correction	+.018	+.040	+.050	+.047	+.034	+.024	+.018	+.009

NOTES.—Readings reduced to temperature 32° Fahrenheit.
Readings marked * interpolated.
Readings marked ′ "reduced to level."

Tambo of Antonio, Rio Nercua, New Granada. Syphon Barometer, No. 1362.

Data for deducing a table of corrections for horary oscillation.

Date.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.	1, P. M.	2, P. M.
1858.								
February 3	29.621	29.633	29.645	29.646	29.647	29.636	29.623	29.609
February 12	*29.616′	29.625′	29.630′	29.623′	29.622′	29.605′	29.595′	29.570′
Hourly mean	29.619	29.629	29.638	29.640	29.635	29.621	29.609	29.590
Grand mean..........	29.601	29.601	29.601	29.601	29.601	29.601	29,601	29.601
Horary correction	— 018	—.028	—.037	—.039	—.034	—.020	—.008	+.011

Date.	3, P. M.	4, P. M.	5, P. M.	6, P. M.	7, P. M.	8, P. M.	9, P. M.
1858.							
February 3.............	29.593	29.569	*29.575	29.593	*29.599	*29.604	29.611
February 12...........	*29.560′	29.544′	29.543′	*29.554′	29.560′	29.567′	29.579′
Hourly mean	29.577	29.557	29.559	29.574	29.580	29.586	29.595
Grand mean..........	29.601	29.601	29 601	29.601	29 601	29.601	29.601
Horary correction.....	+.024	+.044	+.042	+.027	+.021	+.015	+.006

NOTES.—Readings reduced to temperature 32° Fahrenheit.
Readings marked * interpolated.
Readings marked ′ "reduced to level."

Tambo. Syphon Barometer, No. 1363.

Data for deducing a table of corrections for horary oscillation.

Date.	7, A. M.	8, A. M.	9, A. M.	10, A. M.	11, A. M.	12, M.	1, P. M.	2, P. M.
1858.								
February 3	29.625	29.632	29.640	29.638	20.638	29.635	29.621	29.601
February 12	29.624	29.635	29.640	29.635	29.635	29.626	29.610	29.593
Hourly mean	29.625	29.634	29.640	29.637	29.637	29.631	29.616	29.597
Grand mean..........	29.609	29.609	29.609	29.609	29.609	29.609	29.609	29.609
Horary correction.....	—.016	—.025	—.031	—.028	—.028	—.022	—.007	+.012

Date.	3, P. M.	4, P. M.	5, P. M.	6, P. M.	7, P. M.	8, P. M.	9, P. M.
1858.							
February 3	29.596	29.581	*29.584	29.597	*29.607	*29.612	29.623
February 12	*29.581	29.566	29.562	*29.569	29.573	29.589	29.607
Hourly mean.........	29.589	29.574	29.573	29.583	29.590	29.601	29.615
Grand mean...........	29.609	29.609	29.609	29.609	29.609	29.600	29.609
Horary correction.....	+.020	+.035	+.036	+.026	+.019	+.008	—.006

NOTES.—Readings reduced to 32° Fahrenheit.
Readings marked * interpolated.

Readings prepared for computation not already given in the tables for deducing the horary correction. Corrections applied as in the example given heretofore.

NOTES.—The corrections for horary oscillation used at this station are those obtained at Turbo. The readings marked ' are "reduced to level."

Date and hour.	Station.	No. of barometer.	Corrected readings.	Date and hour.	Station.	No. of barometer.	Corrected readings.
1857.				1857.			
Nov. 14,				Nov. 14,			
8 P. M.	Cartajena	1258	29.965	8 P. M.	Cartajena	1362	29.900
9	......do	..do..	29.857	9	......do	..do..	29.878
Nov. 15,				Nov. 15,			
6 A. M.	......do	..do..	29.861	6 A. M.	......do	..do..	29.902
7	......do	..do..	29.844	7	......do	..do..	29.890'
10	......do	..do..	29.874	10	......do	..do..	29.901'
12	......do	..do..	29.873	12	......do	..do..	29.899'
1 P. M.	......do	..do..	29.884	1 P. M.	......do	..do..	29.896'
4.45	......do	..do..	29.878	4.45	......do	..do..	29.926'
5.15	......do	..do..	29.879	5.15	......do	..do..	29.927'
6	......do	..do..	29.875	6	......do	..do..	29.904'
7	......do	..do..	29.874	7	......do	..do..	29.906'
8	......do	..do..	29.877	8	......do	..do..	29.904'
9	......do	..do..	29.885	9	......do	..do..	29.888'
Nov. 16,				Nov. 16,			
6 A. M.	......do	..do..	29.833	6 A. M.	......do	..do..	29.871
7	......do	..do..	29.851	7	......do	..do..	29.873
10	......do	..do..	29.873	10	......do	..do..	29.871
11	......do	..do..	29.879	11	......do	..do..	29.878
12	......do	..do..	29.875	12	......do	..do..	29.862
Nov. 17,				Nov. 17,			
6 A. M.	......do	..do..	29.853	6 A. M.	......do	..do..	29.879
5 P. M.	......do	..do..	29.884	5 P. M.	......do	..do..	29.899
7	......do	..do..	29.874	7	......do	..do..	29.892
8	......do	..do..	29.925	8	......do	..do..	29.872
9	......do	..do..	29.880	9	......do	..do..	29.854
Nov. 18,				Nov. 18,			
7 A. M.	......do	..do..	29.884				
7 P. M.	......do	..do..	29.860	7 P. M.	......do	..do..	29.890
8	......do	..do..	29.873	8	......do	..do..	29.887
9	......do	..do..	29.886	9	......do	..do..	29.868
Nov. 19,				Nov. 19,			
7 A. M.	......do	..do..	29.895	7 A. M.	......do	..do..	29.879
10	......do	..do..	29.942	10	......do	..do..	29.904
11	......do	..do..	29.947	11	......do	..do..	29.916
12	......do	..do..	29.934	12	......do	..do..	29.896
1 P. M.	......do	..do..	29.941	1 P. M.	......do	..do..	29.913
2	......do	..do..	29.951				
Nov. 25,				Nov. 25,			
12 A. M.	......do	..do..	29.891	12 A. M.	......do	..do..	29.883
Nov. 26,				Nov. 26,			
6.30 A. M.	......do	..do..	29.922	6.30 A. M.	......do	..do..	29.927
Nov. 27,				Nov. 27,			
6 A. M.	......do	..do..	29.902	6 A. M.	......do	..do..	29.895
6.30	......do	..do..	29.894				
7	......do	..do..	29.888				
Dec. 4,				Dec. 4,			
4 P. M.	Turbo, Gulf of Darien	1258	29.913	4 P. M.	Turbo, Gulf of Darien	1362	29.908
5	......do	..do..	29.901	5	......do	..do..	29.895
6	......do	..do..	29.897	6	......do	..do..	29.884
7	......do	..do..	29.896	7	......do	..do..	29.899
8	......do	..do..	29.902	8	......do	..do..	29.889
9	......do	..do..	29.925	9	......do	..do..	29.921
Dec. 7,				Dec. 7,			
6 A. M.	......do	..do..	29.880	6 A. M.	......do	..do..	29.844
7	......do	..do..	29.875	7	......do	..do..	29.888
8	......do	..do..	29.876	8	......do	..do..	29.896
9	......do	..do..	29.864	9	......do	..do..	29.883
10	......do	..do..	29.862	10	......do	..do..	29.867
Dec. 4,				Dec. 4,			
4 P. M.	......do	1265	29.901	4 P. M.	......do	1363	29.922
5	......do	..do..	29.897	5	......do	..do..	29.914
6	......do	..do..	29.891	6	......do	..do..	29.909
7	......do	..do..	29.896	7	......do	..do..	29.909
	......do	..do..	29.896	8	......do	..do..	29.886
	......do	..do..	29.914	9	......do	..do..	29.900

PREPARED READINGS—Continued.

Date and hour.	Station.	No. of barometer.	Corrected reading.	Date and hour.	Station.	No. of barometer.	Corrected reading.
1857.				1857.			
Dec. 7,				Dec. 7.			
6 A. M.	Turbo	1265	29.876	6 A. M.	Turbo	1363	29.888
7	......do	..do..	29.875	7	......do	..do..	29.948
8	......do	..do..	29.872	8	......do	..do..	29.893
9	......do	..do..	29.870	9	......do	..do..	29.874
10	......do	..do..	29.864	10	......do	..do..	29.859
1858.				1858.			
March 6,				March 6,			
4.30 P. M.	Turbo	1362	29.889	4.30 P. M.	Turbo	1363	29.903
6	......do	..do..	29.874	6	......do	..do..	29.906
8.45	......do	..do..	29.866	8.45	......do	..do..	29.869
March 7,				March 7,			
8 A. M.	......do	..do..	29.851	8 A. M.	......do	..do..	29.851
10	......do	..do..	29.844	10	......do	..do..	29.834
11	......do	..do..	29.839	11	......do	..do..	29.836
2 P. M.	......do	..do..	29.846	2 P. M.	......do	..do..	29.839
4	......do	..do..	29.851	4	......do	..do..	29.861
6	......do	..do..	29.847	6	......do	..do..	29 861
8.55	......do	..do..	29.820	8.55	......do	..do..	29.830
March 8,				March 8,			
11.5 A. M.	......do	..do..	29.827	11.5 A. M.	......do	..do..	29.824
1 P. M.	......do	..do..	29.841	1 P. M.	......do	..do..	29.838
2	......do	..do..	29.855	2	......do	..do..	29.848
4	......do	..do..	29.867	4	......do	..do..	29.875
5	......do	..do..	29.863	5	......do	..do..	29.878
9	......do	..do..	29.834	9	......do	..do..	29.846
March 9,				March 9,			
7 A. M.	......do	..do..	29.859	7 A. M.	......do	..do..	29.892
10	......do	..do..	29.935	10	......do	..do..	29.903'
12	......do	..do..	20.941	12	......do	..do..	29.916'
3 P. M.	......do	..do..	29.978	3 P. M.	......do	..do..	29.954'
4	......do	..do..	29.996	4	......do	..do..	29.973'
5	......do	..do..	29.998	5	......do	..do..	29.958'
7.15	......do	..do..	29.988	7.15	......do	..do..	29.953'
8.30	......do	..do..	29.972	8.30	......do	..do..	29.920'
March 10,				March 10,			
7 A. M.	......do	..do..	29.955	7 A. M.	......do	..do..	29.945
10	......do	..do..	29.932	10	......do	..do..	29.930'
1 P. M.	......do	..do..	29.984	1 P. M.	......do	..do..	29.994'
2.30	......do	..do..	29.975	2.30	......do	..do..	29 985'
6	......do	..do..	29.950	6	......do	..do..	29.982'
8.30	......do	..do..	29.919	8.30	......do	..do..	29.956
March 11,				March 11,			
7.30 A. M.	......do	..do..	29.905'	7.30 A. M.	......do	..do..	29.905
10	......do	..do..	29.891'	10	......do	..do..	29.933'
3.15 P. M.	......do	..do..	29.893'	3.15 P. M.	......do	..do..	29.923'
6	......do	..do..	29.881'	6	......do	..do..	29.916'
7.30	......do	..do..	29.897'	7.30	......do	..do..	29.908'
9	......do	..do..	20.844'	9	......do	..do..	29.888'
March 12,				March 12,			
7.15 A. M.	......do	..do..	29.840	7.15 A. M.	......do	..do..	29.854
9	......do	..do..	29.843'	9	......do	..do..	29.852'
11	......do	..do..	29.842'	11	......do	..do..	29.851'
2.15 P. M.	......do	..do..	29.876'	2.15 P. M.	......do	..do..	29.871'
3	......do	..do..	29.855'	3	......do	..do..	29.873'
5	......do	..do..	29.865'	5	......do	..do..	29.873'
7.30	......do	..do..	29.861'	7.30	......do	..do..	29.859'
9	......do	..do..	29.823	9	......do	..do..	29.845'
March 13,				March 13,			
7.15 A. M.	......do	..do..	29.825	7.15 A. M.	......do	..do..	29.832
10	......do	..do..	29.826	10	......do	..do..	29.811
11	......do	..do..	29.814	11	......do	..do..	29.816
1857.				1857.			
Dec. 26,				Dec. 26,			
2 P. M.	First Camp on Truandó	1362	29.834	2 P. M.	First Camp on Truandó	1363	29.834
3	......do	..do..	29.821	3	......do	..do..	29.829
4	......do	..do..	29.810	4	......do	..do..	29.815
5	......do	..do..	29.808	5	......do	..do..	29.818
6	......do	..do..	29.809	6	......do	..do..	29.823
7	......do	..do..	29.806	7	......do	..do..	29.819
8	......do	..do..	29.797	8	......do	..do..	29.832
9	......do	..do..	29.796	9	......do	..do..	29.832
Dec. 9,				Dec. 9,			
6 A. M.	......do	..do..	29.811				
7	......do	..do..	29.801	7 A. M.	......do	..do..	29.797
10	......do	..do..	29.779'	10	......do	..do..	29.778'
2.15 P. M.	......do	..do..	29.775	2.15 P. M.	......do	..do..	29.779'

PREPARED READINGS—Continued.

Date and hour.	Station.	No. of barometer.	Corrected readings.
1857. Dec. 9, 5 P. M.	First Camp on Truandó	1362	29.775′
Dec. 30, 7.15 A. M.	do	do	29.739
2 P. M.	do	do	29.749′
5.15	do	do	29.747′
9	do	do	29.736′
Dec. 31, 6 A. M.	do	do	29.772
7	do	do	29.773
12	do	do	29.777
2 P. M.	do	do	29.782
5	do	do	29.819
9	do	do	29.846
1858. Jan. 1, 9 A. M.	First Camp on Truandó	1362	29.817
10	do	do	29.813
2 P. M.	do	do	29.837
5	do	do	29.845
9	do	do	29.832
Jan. 3 7 A. M.	do	do	29.808
10	do	do	29.801′
2.15 P. M.	do	do	29.815′
5	do	do	29.841′
9	do	do	29.826′
Jan. 4, 7 A. M.	do	do	29.818
10	do	do	29.858′
4.30 P. M.	do	do	29.831′
5	do	do	29.827′
9	do	do	29.818′
Jan. 5, 7 A. M.	do	do	29.837
10	do	do	29.837′
2 P. M.	do	do	29.816′
5	do	do	29.823′
9	do	do	29.822′
Jan. 6, 7 A. M.	do	do	29.876
10	do	do	29.875′
2 P. M.	do	do	29.825′
5	do	do	29.831′
9	do	do	29.832′
Jan. 7, 7 A. M.	do	do	29.851
1857. Dec. 25, 12 M.	First Camp on Truandó	1258	29.862
2 P. M.	do	do	29.847
3	do	do	29.831
4	do	do	29.833
5.15	do	do	29.829
Dec. 29, 7 A. M.	do	do	29.769
10	do	do	29.751′
2.15 P. M.	do	do	29.759′
5	do	do	29.760′
Dec. 30, 7.15 A. M.	do	do	29.749
2 P. M.	do	do	29.754′
5.15	do	do	29.748′
9	do	do	29.737′
Dec. 31, 7 A. M.	do	do	29.809
12	do	do	29.808

Date and hour.	Station.	No. of barometer.	Corrected readings.
1857. Dec. 9, 5 P. M.	First Camp on Truandó	1363	29.779
Dec. 30, 7.15 A. M.	do	do	29.746
2 P. M.	do	do	29.796
5.15	do	do	29.791
9	do	do	29.766
Dec. 31, 7 A. M.	do	do	29.771
12	do	do	29.772
2 P. M.	do	do	29.794
5	do	do	29.836
1858. Jan. 1, 9 A. M.	First Camp on Truandó	1363	29.802
10	do	do	29.807
2 P. M.	do	do	29.844
5	do	do	29.850
9	do	do	29.810
Jan. 3, 7 A. M.	do	do	29.808
10	do	do	29.801
2.15 P. M.	do	do	29.827
5	do	do	29.847
9	do	do	29.815
Jan. 4, 7 A. M.	do	do	29.808
10	do	do	29.800′
4.30 P. M.	do	do	29.840′
5	do	do	29.842′
9	do	do	29.814′
Jan. 5, 7 A. M.	do	do	29.819
10	do	do	29.834′
2 P. M.	do	do	29.827′
5	do	do	29.849′
9	do	do	29.805′
Jan. 6, 7 A. M.	do	do	29.852
2 P. M.	do	do	29.824′
5	do	do	29.833′
9	do	do	29.816′
Jan. 7, 7 A. M.	do	do	29.862
1857. Dec. 26, 2 P. M.	First Camp on Truandó	1264	29.824
3	do	do	29.817
4	do	do	29.805
5	do	do	29.807
6	do	do	29.797
7	do	do	29.813
8	do	do	29.804
9	do	do	29.810
Dec. 29, 7 A. M.	do	do	29.790
10	do	do	29.762′
2.15 P. M.	do	do	29.756′
5	do	do	29.757′
Dec. 30, 7.15 A. M.	do	do	29.767
2 P. M.	do	do	29.765′
5.15	do	do	29.752′
9	do	do	29.760′

PREPARED READINGS—Continued.

Date and hour.	Station.	No. of barometer.	Corrected readings.
1857.			
Dec. 31,			
2 P. M.	First Camp on Truandó	1258	29.793
5	......do..................	..do..	29.865
9	......do..................	..do..	29.835
1858.			
Jan. 1,			
9 A. M.	First Camp on Truandó	1258	29.813
10	......do..................	..do..	29.814
2 P. M.	......do..................	..do..	29.836
5	......do..................	..do..	29.853
9	......do..................	..do..	29.827
Jan. 3,			
7 A. M.	......do..................	..do..	29.811
10	......do..................	..do..	29.813
1.30 P. M.	......do..................	..do..	29.826
2.15	......do..................	..do..	29.832
5	......do..................	..do..	29.833
Jan. 11,			
7 A. M.	Camp at Tocame........	1362	29.801
2 P. M.	......do..................	..do..	29.806
9	......do..................	..do..	29.814
Jan. 12,			
7 A. M.	......do..................	..do..	29.773
Feb. 17,			
2 P. M.	......do..................	..do..	29.876
3	......do..................	..do..	29.880
4	......do..................	..do..	29.868
6	......do..................	..do..	29.859
9.10	......do..................	..do..	29.862
Jan. 20,			
2 P. M.	Observatory Hill........	..do..	29.633
Jan. 21,			
7.30 A. M.	......do..................	..do..	29.677
9	......do..................	..do..	29.667
10.30	......do..................	..do..	29.664
1 P. M.	......do..................	..do..	29.679
3	......do..................	..do..	29.680
3.55	......do..................	..do..	29.684
9.5	......do..................	..do..	29.669
Jan. 22,			
7.15 A. M.	......do..................	..do..	29.672
9	......do..................	..do..	29.662
10	......do..................	..do..	29.660
1 P. M.	......do..................	..do..	29.665
2	......do..................	..do..	29.672
4	......do..................	..do..	29.677
7.15	......do..................	..do..	29.673
Jan. 23,			
7 A. M.	......do..................	..do..	29.641
9.50	......do..................	..do..	29.641
12.15	......do..................	..do..	29.667
1.40 P. M.	......do..................	..do..	29.688
4	......do..................	..do..	29.687
7	......do..................	..do..	29.682

Date and hour.	Station.	No. of barometer.	Corrected readings.
1858.			
Feb. 18,			
7 A. M.	First Camp on Truandó	1362	29.881
Jan. 11,			
7 A. M.	Camp at Tocame	1363	29.806
2 P. M.	......do..................	..do..	29.806
9	......do..................	..do..	29.812
Jan. 12,			
7 A. M.	......do..................	..do..	29.891
Feb. 17,			
2 P. M.	......do..................	..do..	29.863
3	......do..................	..do..	29.877
4	......do..................	..do..	29.868
6	......do..................	..do..	29.861
9.10	......do..................	..do..	29.859
Feb. 18,			
7 A. M.	......do..................	..do..	29.897
Jan. 18,			
7 A. M.	Camp at foot of Saltos..	1333	29.737
10	......do..................	..do..	29.698
2 P. M.	......do..................	..do..	29.716
9	......do..................	..do..	29.716
Jan. 19,			
7 A. M.	......do..................	..do..	29.730
2 P. M.	......do..................	..do..	29.734
5	......do..................	..do..	29.755
Jan. 20,			
7 A. M.	......do..................	..do..	29.739
9	......do..................	..do..	29.716
11	......do..................	..do..	29.724
2 P. M.	......do..................	..do..	29.777
5	......do..................	..do..	29.741
9	......do..................	..do..	29.735
Jan. 21,			
7 A. M.	......do..................	..do..	29.764
8	......do..................	..do..	29.760
12	......do..................	..do..	29.770
2 P. M.	......do..................	..do..	29.791
4.5	......do..................	..do..	29.793
5	......do..................	..do..	29.785
9	......do..................	..do..	29.767
Jan. 22,			
7 A. M.	......do..................	..do..	29.784
10.15	......do..................	..do..	29.761
2.5	......do..................	..do..	29.786
5	......do..................	..do..	29.775
Jan. 23,			
7.15 A. M.	......do..................	..do..	29.753
8	......do..................	..do..	29.749
9.15	......do..................	..do..	29.724
10	......do..................	..do..	29.724
11	......do..................	..do..	29.747
1 P. M.	......do..................	..do..	29.770
2	......do..................	..do..	29.779
3	......do..................	..do..	29.787
4.10	......do..................	..do..	29.795
5	......do..................	..do..	29.788
6	......do..................	..do..	29.780

PREPARED READINGS—Continued.

Date and hour.	Station.	No. of barometer.	Corrected readings.
1858. Jan. 24, 9 A. M.	Observatory Hill	1362	29.636
11	......do...............	..do..	29.630
1 P. M.	......do...............	..do..	29.651
3	......do...............	..do..	29.678
9.5	......do...............	..do..	29.656
Jan. 26, 7.15 A. M.	......do...............	..do..	29.616
8.30	......do...............	..do..	29.645
10.30	......do...............	..do..	29.658
2 P. M.	......do...............	..do..	29.655
6	......do...............	..do..	29.637
Jan. 27, 7 A. M.	......do...............	..do..	29.626
10	......do...............	..do..	29.609
Jan. 28, 7 A. M.	......do...............	..do..	29.637
Feb. 15, 7.15 A. M.	......do...............	..do..	29.689
9	......do...............	..do..	29.677
11	......do...............	..do..	29.673
1.10 P. M.	......do...............	..do..	29.700
2	......do...............	..do..	29.696
4	......do...............	..do..	29.706
8	......do...............	..do..	29.689
9	......do...............	..do..	29.688
Jan. 28, 5 P. M.	Camp at head of Salto Grande	1352	29.723
6	......do...............	..do..	29.709
7	......do...............	..do..	29.718
8	......do...............	..do..	29.722
9	......do...............	..do..	29.721
Jan. 31, 6 A. M.	Junction of Rios Nercua and Truandó	1362	29.704
5 P. M.	......do...............	..do..	29.649
6	......do...............	..do..	29.645
7	......do...............	..do..	29.646
8.10	......do...............	..do..	29.645
9	......do...............	..do..	29.644
Feb. 1, 7 A. M.	......do...............	..do..	29.639
8	......do...............	..do..	29.638
Feb. 13, 8 P. M.	......do...............	..do..	29.727
9	......do...............	..do..	29.727
Feb. 14, 6.40 } 7 7.20 } A. M.	} ....do...............	..do..	29.724
Feb. 2, 5 P. M.	Tambo of Antonio	1362	29.621
6	......do...............	..do..	29.612
7.15	......do...............	..do..	29.608
9	......do...............	..do..	29.601
Feb. 4, 7 A. M.	......do...............	..do..	29.656
Feb. 13, 6.30 A. M.	......do...............	..do..	29.615
Feb. 4, 4 P. M.	Rancho on Rio Hingadór	1362	29.114
5	......do...............	..do..	29.095
6	......do...............	..do..	29.098
7	......do...............	..do..	29.112
Feb. 5, 7 A. M.	......do...............	..do..	23.089
Feb. 10, 6 P. M.	......do...............	..do..	29.031
7	......do...............	..do..	29.048
8	......do...............	..do.	29.040
9	......do...............	..do..	29.051
Feb. 11, 7 A. M.	......do...............	..do..	29.029
Feb. 5, 5 P. M.	Camp on Rio Totumia, near Dos Bocas	1362	29.873
	......do...............	..do..	29.865

Date and hour.	Station.	No. of barometer.	Corrected readings.
1858. Jan. 24, 7 A. M.	Camp at foot of Saltos..	1363	29.751
2 P. M.	......do...............	..do..	29.771
9	......do...............	..do..	29.798
Jan. 26, 7.15 A. M.	Observatory Hill	1363	29.633
8.30	......do...............	..do..	29.619
10.30	......do...............	..do..	29.637
2 P. M.	......do...............	..do..	29.649
6	......do...............	..do..	29.635
Jan. 27, 7 A. M.	......do...............	..do..	29.627
10	......do...............	..do..	29.622
Jan. 28, 7 A. M.	......do...............	..do..	29.639
Feb. 15, 7 A. M.	......do...............	..do..	29.686
9	......do...............	..do..	29.669
11	......do...............	..do..	29.701
1.10 P. M.	......do...............	..do..	29.712
2	......do...............	..do..	29.713
4	......do...............	..do..	29.697
8	......do...............	..do..	29.689
9	......do...............	..do..	29.677
Jan. 28, 5 P. M.	Camp at head of Salto Grande	1363	29.728
6	......do...............	..do..	29.718
7	......do...............	..do..	29.719
8	......do...............	..do..	29.725
9	......do...............	..do..	29.734
Jan. 31, 6 A. M.	Junction of Rios Nercua and Truandó	1363	29.709
5 P. M.	......do...............	..do..	29.661
6	......do...............	..do..	29.659
7	......do...............	..do..	29.659
8.10	......do...............	..do..	29.652
9	......do...............	..do..	29.650
Feb. 1 7 A. M.	......do...............	..do..	29.642
8	......do...............	..do..	29.696
Feb. 13, 8 P. M.	......do...............	..do..	29.721
9	......do...............	..do..	29.718
Feb. 14, 6.40 } 7 7.20 } A. M.	} ....do...............	..do..	29.739
Feb. 2, 5 P. M.	Tambo of Antonio	1362	29.619
6	......do...............	..do..	29.612
7.15	......do...............	..do..	29.608
9	......do...............	..do..	29.606
Feb. 4, 7 A. M.	......do...............	..do..	29.620
Feb. 13, 6.30	......do...............	..do..	29.611
Feb. 4, 4 P. M.	Rancho on Rio Hingadór	1362	29.103
5	......do...............	..do..	29.111
6	......do...............	..do..	29.110
7	......do...............	..do..	29.128
Feb. 5, 7 A. M.	......do...............	..do..	29.112
Feb. 10, 6 P. M.	......do...............	..do..	29.041
7	......do...............	..do..	29.058
8	......do...............	..do..	29.048
9	......do...............	..do..	29.043
Feb. 11, 7 A. M.	......do...............	..do..	29.023
Feb. 5, 5 P. M.	Camp on Rio Totumia, near Dos Bocas	1362	29.879
6	......do...............	. do..	29.877

PREPARED READINGS—Continued.

Date and hour.	Station.	No. of barometer.	Corrected readings.
1858.			
Feb. 5, 7 P. M.	Camp on Rio Totumia, near Dos Bocas	1362	29.886
8	do	do	29.882
9	do	do	29.889
Feb. 6, 7 A. M.	do	do	29.863
8	do	do	29.864
Feb. 9, 4 P. M.	do	do	29.791
5	do	do	29.785
6	do	do	29.777
7	do	do	29.780
8	do	do	29.791
Feb. 10, 7 A. M.	do	do	29.794
Feb. 6, 5 P. M.	Isla de la Playa, Pacific Coast	1362	29.842
7	do	do	29.855
Feb. 7, 7.30 A. M.	do	do	29.887
9.30	do	do	29.892
10.30	do	do	29.890
11.30	do	do	29.881
2.15 P. M.	do	do	29.878
4.15	do	do	29.882
6.10	do	do	29.875
7.15	do	do	29.867
Feb. 8, 7 A. M.	do	do	29.809
8.30	do	do	29.819
10	do	do	29.812
11	do	do	29.808
1 P. M.	do	do	29.815
2.5	do	do	29.805
5.15	do	do	29.820
6	do	do	29.819
7.30	do	do	29.856
9	do	do	29.854
Feb. 9, 7.15 A. M.	do	do	29.810
Feb. 10, 9.45 A. M.	Rio Chupepe	1352	29.641
10	do	do	29.637
10.30	do	do	29.624
11	do	do	29.617
11.20	do	do	29.619
Feb. 11. 8.30 A. M.	Dividing Ridge of the Cordilleras	1362	28.918
9	do	do	28.913
9.30	do	do	28.911
10	do	do	28.906
12.45	Log Crossing of Rio Hingadór	1362	29.057
1.15 P. M.	do	do	29.057
1.40	do	do	29.047
2	do	do	29.050
3.45	First ridge west of Rio Nercua	1352	28.807
4	do	do	28.819
4.15	do	do	28.823
4.30	do	do	28.810
4.45	do	do	28.802
Feb. 14, 11 A. M.	Head of Saltos of Rio Truandó	1362	29.761
12	do	do	29.741
12.30	do	do	29.735
1 P. M.	do	do	29.722
1.30	do	do	29.718

Date and hour.	Station.	No. of barometer.	Corrected readings.
1858.			
Feb. 5, 7 P. M.	Camp on Rio Totumia, near Dos Bocas	1363	29.883
8	do	do	29.889
9	do	do	29.885
Feb. 6. 7 A. M.	do	do	29.874
8	do	do	29.874
Feb. 9. 4 P. M.	do	do	29.797
5	do	do	29.797
6	do	do	29.799
7	do	do	29.798
8	co	do	29.790
Feb. 10, 7 A. M.	do	do	29.781
Feb. 6, 5 P. M.	Isla de la Playa, Pacific Coast	1363	29.856
7	do	do	29.852
Feb. 7, 7.30 A. M.	do	do	29.833
9.30	do	do	29.858
10.30	do	do	29.831
11.30	do	do	29.865
2.15	do	do	29.875
4.15	do	do	29.862
6.10	do	do	29.855
7.15	do	do	29.847
Feb. 8. 7 A. M.	do	do	29 830
8.30	do	do	29.842
10	do	do	29.842
11	do	do	29.826
1 P. M.	do	do	29.812
2.5	do	do	29.813
5.15	do	do	29.825
6	do	do	29.827
Feb. 10, 9.45 A. M.	Rio Chupepe	1363	29.646
10	do	do	29.639
10.30	do	do	29.630
11	do	do	29,631
11.20	do	do	29.627
Feb. 11, 8.30 A. M.	Dividing Ridge of the Cordilleras	1363	28.924
9	do	do	28.916
9.30	do	do	28.908
10	do	do	28.905
12.45	Log Crossing of Rio Hingadór	1363	28.887
1.15 P. M.	do	do	28.904
1.40	do	do	28.932
2	do	do	28.934
3.45	First ridge west of Rio Nercua	1363	28.814
4	do	do	28.819
4.15	do	do	28.823
4.30	do	do	28.819
4.45	do	do	28.812
Feb. 14, 11 A. M.	Head of Saltos of Rio Truandó	1363	29.771
12	do	do	29.753
12.30	do	do	29.737
1 P. M.	do	do	29.717
1.30	do	do	29.715

XIX *b.—Results of meteorological observations made under the*

Date.	STATION.	No. of Barometer.	Mean daily reading of the barometer, corrected and reduced to 32° Fah.	READINGS OF THERMOMETERS. Dry. Highest.	Dry. Lowest.	Dry. Mean daily value.	Dew point. Mean daily value.	DIFFERENCE BETWEEN THE DEW POINT TEMPERATURE AND AIR TEMPERATURE. Mean daily value.	Greatest.	Least.
1857. Dec. 5	Turbo, Gulf of Darien, New Granada.	Syp. 1362	29.910	90.5	74.6	80.8	....	....	....	....
5		" 1363	29.913	....	....	....	....	....	....	....
5		Cis. 1258	29.914	....	....	....	....	....	....	....
5		" 1265	29.910	....	....	....	....	....	....	....
6		Syp. 1362	29.895	94	76	82	....	....	....	....
6		" 1363	29.900	....	....	....	....	....	....	....
6		Cis. 1258	20.898	....	....	....	....	....	....	....
6		" 1255	29.895	....	....	....	....	....	....	....
19		" 1265	29.829	86	75	78.7	76	5.3	10	.75
26		" 1265	29.860	85.5	75.5	79.5	75.7	5.1	9.25	1·5
1858. Jan. 2	Isla de los Muertos, Gulf of Darien.	" 1265	29.859	85	78.5	81	76.7	4.9	9	2.25
9		" 1265	29.844	83	78.5	79.8	75.9	4.8	6	3
16	Sand Point......	" 1265	29.863	84.5	76	79.7	74.7	6.2	11.25	1.5
23	North Base......	" 1265	29.874	83.75	....	....	75.8	6.9	8.25	4.875
1857. Dec. 26	First Camp on Rio Truandó, New Granada.	" 1258	29.825	78	73.5	75.5	....	....	....	....
27		" 1258	29.826	79	73	75.5	....	....	....	....
27		" 1264	29.822	....	....	....	....	....	....	....
27		Syp. 1362	29.816	....	....	....	....	....	....	....
27		" 1363	29.829	....	....	....	....	....	....	....
28		Cis. 1258	29.817	79.75	73	76	....	....	....	....
28		" 1264	29.816	....	....	....	....	....	....	....
28		Syp. 1362	29.811	....	....	....	....	....	....	....
28		" 1363	29.818	....	....	....	....	....	....	....
29		....	....	....	....	....	....	....	1.75	.25
30		Cis. 1258	29.770	76.75	73	74.8	74.3	.53	.85	.25
30		" 1264	29.771	....	....	....	....	....	....	....
30		Syp. 1362	29.749	....	....	....	....	....	....	....
30		" 1363	29.769	....	....	....	....	....	....	....
31		Cis. 1258	29.817	80	72.5	75.7	74.12	1.55	4.2	.00
31		Syp. 1362	29.799	....	....	....	....	....	....	....
1858. Jan. 1		Cis. 1258	29.841	78	74	75.6	....	....	75	.00
1		Syp. 1362	29.799	....	....	....	....	....	....	....
2		Cis. 1258	29.829	80.25	73	76.8	74.65	2.27	5.45	.4
2		Syp. 1362	29.821	....	....	....	....	....	....	....
2		" 1363	29.826	....	....	....	....	....	....	....
3		Cis. 1258	29.837	81.5	72.25	75.9	74	1.9	5.1	.00
3		Syp. 1362	29.817	....	....	....	....	....	....	....
3		" 1363	29.818	....	....	....	....	....	....	....
4		....	....	....	71	....	....	....	....	.00
5		" 1362	29.837	77.5	71.5	75	....	....	....	.00
5		" 1363	29.828	....	....	....	....	....	....	....
6		" 1362	29.839	79	71	75.3	73.8	1.53	1.95	.95
6		" 1363	29.836	....	....	....	....	....	....	....
9	Tocame on the Rio Truandó, New Granada.	" 1362	29.781	89.5	69	76.8	....	....	10.75	2.2
9		" 1363	29.785	....	....	....	....	....	....	....
10		" 1362	29.808	88	71.5	76.9	72.95	3.9	12	1.45
10		" 1363	29.807	....	....	....	....	....	....	....
11		" 1362	29.800	83	73	76.7	....	....	....	.95
11		" 1363	29.806	....	....	....	....	....	....	....
16	Foot of Saltos of Rio Truandó.	" 1363	29.768	79.5	74	76.1	74.34	1.8	3.07	.95
17		" 1363	29.741	80.5	73.5	76.2	73.5	2.5	4.3	1.6
18		" 1363	29.725	80.5	72.75	76.3	73.4	2.37	4.1	.95
19		" 1363	....	79	73.5	....	....	....	4 2	....

direction of Lieut. N. Michler, Corps Topographical Engineers.

Wind.				Rain, in inches, read at 12, noon.	Clouds and weather.		Remarks.
General direction.		Force.					
A. M.	P. M.	A. M.	P. M.		A. M.	P. M.	
E. NE	SW	1	2.5		Cu. cir., cu. 9.	Cu. cir., cu. 9.	Raining during the night.
SW	S.	2	1	.110	Cir., cu. 6.	Cir., cu. 1.	
SE	NW	1	4		St. cu., cu. 4, fair.	Cu. st., cu. 2, fair.	Slight sprinkling of rain at 1.30, p. m.
SE. and S.	SW. and W.	1	1.5		St. cu., cu. 9, humid.	St. cu., cu. 4, fair.	The readings of the wet and dry bulbs were only between 6, a. m., and 6, p. m., and are given for that time from Dec. 19 to Jan. 23, at Turbo. CHAS. HEYNE, *Observer.*
N. NW	NW	2	4		Nim. cu. 8, fair, var.	Cu. st., cu. 2, fair.	
N. NE. and NE.	NW	2	4.5		Cu. nim. 2, fair.	Cu. nim., st. 1, fair.	
NE	N	2	4		St. cu. 8, fair.	Cu. st., cu. 9, drizzly, var.	
N. to NW	NW	3	4.5		Cu. cu., cu. 3 to 9, fair.	St. cu. 3 to 9, var., fair.	
					Overcast		
					Fair	Overcast	
					Overcast	Fair	
						Cloudy	
					Rainy	Cloudy	
					Clear	Rainy	
				2.01	Rainy	Clear	
				.05	Cloudy, 4.	Cloudy 5, clear, rainy.	
				.00	Overcast	Clear, rainy	
				1.35	Cloudy	Overcast, rainy	
				.29	Overcast	Rainy	
				.09	Clear	Clear	
		(Jan. 8.)		.24	Cu. cir., cu. 4, fair.	Fair.	
	N. and W.		1 to 2		Cu. cir., cloudy.	Cir. cu., cir. cu., cu. st. 5.	
					Overcast	Cir. cu., clouds 1—6.	
		.2	1		Cu. cir., cu. st., cir. cu. 0—4.	Cir. cu., cir. cu., cu. st. 9.	
N. to W.		1.3	1		Cir. cu. 4 to 9, overcast.	Cir. cu., cu. st. 4—0, clear.	
	NE. to N		2.3		Hazy	Cir. cu.	
			1		Clouds 4, cir.	Cir. cu., cir. st. 7—8.	

Results of meteorological

Date.	STATION.	No. of barometer.	Mean daily reading of the barometer, corrected and reduced to 32° Fah.	READINGS OF THERMOMETERS. Dry. Highest.	Lowest.	Mean daily value.	Dew point. Mean daily value.	DIFFERENCE BETWEEN THE DEW POINT TEMPERATURE AND AIR TEMPERATURE. Mean daily value.	Greatest.	Least.
1858. Jan. 20	Foot of Saltos of Rio Truandó.	Syp. 1363	29.765	80	72.75	75.9	72.6	93.3	5.35	2.125
21		" 1363	29.782	84	74	76.5	74.2	2	5.45	1.45
22		" 1363	....	81	74	76.6	73.5	2.7	4.95	1.45
23		" 1363	....	80	73	....	....	....	5.75	1.45
24		" 1363	29.775	79.25	71	74.75	72.7	1.9	2.6	1.325
26	Observatory Hill, at Falls of Truandó.	....	....	....	68.5	....	....	....	11.57	1.65
27		....	....	....	68	....	....	....	....	1.7
28		....	....	....	....	....	....	....	....	....
29	Camp near head of Saltos Grande, Rio Truandó.	Syp. 1362	29.741	88.8	70.3	77.5	....	....	....	....
29		" 1363	29.744	....	....	....	....	....	....	....
30		" 1362	29.723	88.75	68	75.95	....	....	....	....
30		" 1363	29.733	....	....	....	....	....	....	....
31	Junc'n of Rio Nercua and Truandó.	....	....	....	....	....	....	....	....	....
Feb. 3	Tambo of Antonio, Rio Nercua.	Syp. 1362	29.612	84	72	76.1	71.6	4.2	11.35	1.7
3		" 1363	29.614	....	....	....	....	....	....	....
7	Isla de la Playa..	....	....	90	69.2	....	....	....	....	....
8	Pacific Coast, latitude about 7° 10′	Syp. 1362	29.815	87	72.5	77.4	....	....	15.45	....
12	Tambo of Antonio.	" 1362	29.603	84	73	76.1	....	....	12.95	1.2
12		" 1363	....	....	....	....	....	....	....	....
15	Observatory Hill.	" 1362	29.692	82	74	76.7	....	....	....	....
15		" 1363	29.694	....	....	....	....	....	....	....
17	Camp at Tocame	....	....	94.5	71.75	....	....	....	....	....
21	Pueblo on Rio Atrato, near the Boca del Rio Sucio.	Syp. 1362	29.935	89.25	71	79	70.5	8.6	16.95	2.7
21		" 1363	29.936	....	....	....	....	....	....	....
22		" 1362	29.887	90	73	80.7	72 7	7.9	16.2	2.45
22	Boca de Sucio....	" 1363	29.882	....	....	....	....	....	....	....
23		" 1362	29.882	89.5	74.75	80.8	74.4	6.4	11.45	3.7
23		" 1363	29.869	....	....	....	....	....	....	....
Mar. 7	Turbo, Gulf of Darien, New Granada.	" 1362	29.844	82.5	75	77.8	....	....	10.325	4.2
7		" 1363	29.846	....	....	....	....	....	....	....
8		" 1362	29.846	83	77.1	....	....	....	9.45	3.3
8		" 1363	29.843	....	....	....	....	....	....	....
9		" 1362	29.951	83	76.75	79.2	71.2	8.1	12.6	5.45
9		" 1363	29.936	....	....	....	....	....	....	....
10		....	....	82	75	77.9	72	5.9	8.82	52.7
11		Syp. 1362	29.874	81.75	77.6	79.1	....	....	6.95	3.8
11		" 1363	29.894	....	....	....	....	....	....	....
12		" 1362	29.843	84.5	75.5	79.7	74.1	5.7	10.45	1.575
12		" 1363	29.869	....	....	....	....	....	....	....

observations—Continued.

WIND.				Rain, in inches, read at 12, noon.	CLOUDS AND WEATHER.		REMARKS.
General direction.		Force.					
A. M.	P. M.	A. M.	P. M.		A. M.	P. M.	
......	......	1.3	1	......	Cu. cir. 4......	Cir. cu. 2—3, overcast.	
......	......	1	1	......	Cir., cir. str. 3—6.	Cir., cir. cu., cir. st. 9—0.	
NE.......	......	1 3	0	......	Cir. cu., cu. st. 5—8.	Cir. cu., cir. cu., cu. st. 6—0.	
NE.......	N. NE.......	.3	2	......	Cir. cu., cir. st. 0—5.	Cir. cu., nim. cu. st. 9—1.	
......	......	......	3	......	......	Cu. st., nim. 9—0.	
......	......	1	2	......	Cir., cu. 1, overcast.	Cir. cu., cir. cu. cu. st. ¼—5.	
......	......	1	......	......	Clouds, 10......	......	
......	......	......	......	......	......	Cir. cu. 1—10....	
NE.......	NE.......	1	1	......	Cir., cir. cu. 2—5.	Cir., cir. cu. cu. st. 2—9.	
......	......	......	......	......	......	......	
......	......	.1	1.0	......	Cir. cu., cir. cu. st. 3—9.	Cir. cu., cu. 9—0—10.	
......	......	......	......	......	......	......	
......	NE.......	......	1	......	......	Cir. cu. 10......	
N. to S.......	S. to W.......	1.2	2.1	......	Cir. cu., cir. cu., cu. st. 10—0.	Cir. cu., cir. cu. st. 9—1.	
......	......	......	......	......	......	......	
NE. to E......	SW.......	1	2	......	Cir. cir. cu., cir. st. 1—3.	Cu. 2—0.......	
NE. to E......	W. SW. to S ...	1	1.2	......	Cir. cu., cir. cu., cir. st. 1—3.	Cir. cu., cir. cu. cu. st. 2—10.	
S.......	SE. to S. & SW.	1	3.1	......	Cir. cu., cir. cu., cir. st., cu. st. 5—9.	Cir. nim., cu. st. 9—10.	
......	......	......	......	......	......	......	
N.......	......	1	......	......	Cu. 5.......	Cir. cu., cir. st. 10—1.	
......	......	......	......	......	......	......	
......	......	......	1	......	......	Cir. 0—5.......	
N.......	N. to E.......	1.3	2.3	......	Cir. cu., cu. st. 1.	Cir. cu. st., cu. st. 3.	
......	......	......	......	......	......	......	
N.......	N.......	2	1.2	......	Cir. nim., cir. cu., cir. st. 1—9.	Cir. st., cu. st. 8—10.	Few drops of rain in the a. m.
......	......	......	......	......	......	......	
N.......	N. to E.......	2	1	......	Cir. cu., cir. cu., cir. st., cu. st. 10—6.	Cir. cu. st., cir. cu. cir. st., cu. st. 9—10.	
......	......	......	......	......	......	......	
N.......	N.......	1.3	3.1	......	Cir. cu., cir. st., cu. st., cir. cu. 1—8.	Cu. cu. st. 8.....	Heavy dews at night.
......	......	......	......	......	......	......	
W. to N.......	N.......	3,4,2	2	......	Cu. st. 9—10...	Cu. cu. 9.......	
......	......	......	......	......	......	......	
N.......	N.......	1.2	4.2	......	Cu. cu. st. 9. ..	Cu. nim., cu. st., cir. st. 7—10.	
......	......	......	......	......	......	......	
N.......	N.......	5.2	4.3	......	Nim. cu. st. 10.	Cir. cu. nim., cu. st. 9.	
N.......	N.......	1	4.1	......	Cir. cu. st., cir. cu. 9—7.	Cir. cu. nim., cu. st., cir. st. 10—0.	Showers at noon.
......	......	......	......	......	......	......	
N.......	N.......	1	4	......	Cir. cu. nim., cir. cu., cir. st. 1—6.	Cir. cu., cir. cu. 1—9.	Showers in the distance.
......	......	......	......	......	......	......	

XX.

ASTRONOMICAL OBSERVATIONS AND DETERMINATIONS OF GEOGRAPHICAL POSITIONS OF PRINCIPAL POINTS ON THE INTEROCEANIC SHIP CANAL.

OBSERVER, LIEUT. N. MICHLER, TOP. ENG., U. S. A.

COMPUTER, L. DASER.

Station.	Latitude North.	Longitude West of Greenwich.
	° ′ ″	° ′ ″
Turbo	+8 4 56.1	+76 41 55.5
Hondo	7 33 34.2	
Sucio	7 26 16.6	77 5 40.5
First Camp on Truandó	7 9 27.5	
Tocame	7 9 54.6	77 15 38.2
Saltos	7 4 31.5	77 25 25.3
Tambo	7 6 37.5	77 33 18.4
	7 2 59.6	77 39 57

Station—Turbo.

Date.	No. and kind of observation.	Sidereal chronometer, No. 202.	Sidereal chronometer, No. 196.	Mean time chronom., No. 6220.			
							° ′ ″
1858, Mar. 6	10 pairs of equal altitude of the sun.	—2 55 58.3	—5 6 26.8	Broken.	1858, Mar. 6	12 Circ. mer. alt. of α Argus....	(S.) 8 5 45.3
1858, Mar. 7	9 pairs of equal altitude of the sun.	2 55 56.6	5 6 24.2	Broken.	1858, Mar. 6	2 Circ. mer. alt. of γ Urs. Maj.	(N.) 8 4 9.2
1858, Mar. 12	6 altitudes of the sun.	2 55 41.6	5 6 7.1	Broken.	1858, Mar. 7	3 Circ. mer. alt. of ε Can. Maj.	(S.) 8 5 14.5
					1858, Mar. 8	Circ. mer. alt. of α Argus......	(S.) 8 5 52.9

Station—Turbo.

Equal altitudes of the Sun, March 6, 1858. Observer, Lieutenant N. Michler; Sextant by Pistor & Martins, No. 933; Sidereal Chronometer by Bond & Son, No. 202; Computer, L. Daser. Assumed latitude, 8° 5′ 50″; assumed longitude, — 0° 20′ 24″ (east of Washington Observatory.) Declination, = — 5° 34′ 27″.8; double daily variation, = + 2792″; Sun's A. R. 23*h*. 8*m*. 0*s*.89.

Observed altitudes.	Observed time by chronometer.		$t-t'$.	$\frac{t+t'}{2}$.	Equation of equal altitudes.	Apparent noon.	Sun's A. R.	Error of chronometer at apparent noon.
	A. M.=t.	P. M.=t'.						
° ′ ″	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
55 13 50	11 54 23.5	4 13 43.0	4 19 19.5	2 4 3.25		2 3 59.73		—2 55 58.8
55 13 50	11 56 43.8	4 11 22.8	4 14 39.0	2 4 3.30		2 3 59.78		2 55 58.9
55 58 10	11 57 37.5	4 10 28.0	4 12 50.5	2 4 2.75		2 3 59.23		2 55 58.3
55 58 10	11 59 59.5	4 8 6.7	4 8 6.7	2 4 2.85		2 3 59.33		2 55 58.4
56 45 35	12 1 4.5	4 7 0.2	4 5 55.7	2 4 2.35	—3.52	2 3 58.83	23 8 0.89	2 55 57.9
56 45 35	12 3 28.5	4 4 37.5	4 1 9.0	2 4 3.00		2 3 59.48		2 55 58.6
57 31 10	12 4 27.5	4 3 39.0	3 59 11.5	2 4 3.25		2 3 59.73		2 55 58.8
58 25 10	12 10 50.8	3 57 14.5	3 46 23.7	2 4 2.65		2 3 59.13		2 55 58.2
59 21 40	12 12 38.7	3 55 25.8	3 42 47.1	2 4 2.25		2 3 58.73		2 55 57.8
59 21 40	12 15 3.5	3 53 0.5	3 37 57.0	2 4 2.00		2 3 58.48		2 55 57.6
	12 3 37.78	4 4 27.75	4 0 49.97	2 4 2.76	—3.52	2 3 59.24	23 8 0.89	2 55 58.3

EQUATION OF EQUAL ALTITUDES.

Log A	= — 7.7449	Log B	= + 7.6820
Log S	= + 3.4459	Log S	= + 3.4459
Log tg. L	= + 9.1531	Log tg. D	= — 8.9895
	— 0.3439		— 0.1174
	— 2.207		— 1.311

Station—Turbo.

Equal altitudes of the Sun, March 7, 1858. Observer, Lieutenant N. Michler. Assumed latitude = 8° 5′ 50″; assumed longitude = —0° 20′ 24″ (east of Washington Observatory.) . Computer, L. Daser; Sextant by Pistor & Martins, No. 933; Sidereal Chronometer by Bond & Sons, No. 202. Declination = — 5° 11′ 10″; double daily variation = + 2800″; Sun's A. R. = 23*h*. 11*m*. 42*s*.89.

Observed altitudes.	Observed time by chronometer. A. M. = t.	Observed time by chronometer. P. M. = t'.	$t - t'$.	$\frac{t+t'}{2}$	Equation of equal altitudes.	Apparent noon.	Sun's A. R.	Error of chronometer at apparent noon.
° ′ ″	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
51 26 15	11 41 6.5	4 34 19.5	4 53 13.0	2 7 43.00		2 7 39.57		—2 55 56.7
51 26 15	11 43 24.5	4 32 3.0	4 48 38.5	2 7 43.75		2 7 40.32		2 55 57.4
52 12 25	11 44 24.0	4 31 2.5	4 46 38.5	2 7 43.25		2 7 39.82		2 55 56.9
52 59 50	11 47 48.5	4 27 39.0	4 39 50.5	2 7 43.75		2 7 40.32		2 55 57.4
53 56 20	11 51 50.5	4 23 34.3	4 31 43.8	2 7 42.40	—3.43	2 7 38.97	23 11 42.89	2 55 56.1
53 56 20	11 54 9.5	4 21 16.5	4 27 7.0	2 7 43.00		2 7 39.57		2 55 56.7
54 54 40	11 56 3.5	4 19 21.5	4 23 18.0	2 7 42.50		2 7 39.07		2 55 56.2
54 54 40	11 58 21.5	4 17 3.2	4 18 41.7	2 7 42.35		2 7 38.92		2 55 56.0
55 42 35	11 59 31.5	4 15 54.0	4 16 22.5	2 7 42.75		2 7 39.32		2 55 56.4
	11 50 44.4	4 24 41.5	4 33 57.06	2 7 42.97	—3.43	2 7 39.54	23 11 42.89	—2 55 56.6

EQUATION OF EQUAL ALTITUDES.

Log A	= — 7.7507	Log B	= + 7.6682
Log S	= + 3.4472	Log S	= + 3.4472
Log tg. L	= + 9.1531	Log tg. D	= — 8.9597
	— 0.3510		— 0.0733
	— 2.244		— 0.184

Station—Turbo.

Altitudes of the Sun's U. L. for time, March 12, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Sidereal Chronometer, by Bond & Sons, No. 202; Computer, L. Daser. Assumed latitude = + 8° 4′ 56″; assumed longitude = —0° 29′ 24″ (east of Washington Observatory.) Decl. at app. noon at place = —3° 13′ 44″.

	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	
Observed altitude	48 13 29	48 3 48	47 52 30	47 4 45	46 24 2	45 41 30	
Sun's semi-diameter	— 16 7.4	— 16 7.4	— 16 7.4	— 16 7.4	— 16 7.4	— 16 7.4	
Parallax	+ 6.0	+ 6.0	+ 6.0	+ 6.0	+ 6.0	+ 6.0	
Index Error	2 8.0	2 8.0	2 8.0	2 8.0	2 8.0	2 8.0	
Refraction	— 52.2	— 52.5	— 52.8	— 54.3	— 55.6	— 57.0	
Correction	14 45.6	14 45.9	14 46.2	14 47.7	14 49.0	14 50.4	
True altitude = A	47 58 34	47 49 2	47 37 44	46 49 57	46 9 13	45 26 40	
Latitude = L	8 4 56	8 4 56	8 4 56	8 4 56	8 4 56	8 4 56	
North polar dist = Δ	93 11 0	93 11 0	93 11 0	93 11 0	93 11 0	93 11 0	
2 m	149 14 30	149 4 58	148 53 40	148 5 53	147 25 9	146 42 36	
m	74 37 15	74 32 29	74 26 50	74 2 56	73 42 34	73 21 18	
m—A	26 38 41	26 43 27	26 49 6	27 12 59	27 33 21	27 54 38	
Log. Cos. m	9.42358	9.42577	9.42834	9.43904	9.44795	9.45704	
Log. Sin. (m—A)	9.65172	9.65292	9.65433	9.66025	9.66522	9.67033	
Log. Sin. L	0.00434	0.00434	0.00434	0.00434	0.00434	0.00434	
Log. Cos. Δ	0.00067	0.00067	0.00067	0.00067	0.00067	0.00067	
Log. $(\text{Sin.}^2 \frac{p}{2})$	19.08031	19.08370	19.08768	19.10430	19.11818	19.13238	
Log. Sin. $\frac{p}{2}$	9.54015	9.54185	9.54384	9.55215	9.55909	9.56619	
	h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	
Hour angle (mean sol. interv.)	2 42 21.9	2 43 1.6	2 43 48.5	2 47 7.2	2 49 56.5	2 52 52.9	
Hour angle (sidereal interv.)	2 42 48.6	2 43 28.4	2 44 15.4	2 47 34.7	2 50 24.4	2 53 21.3	
Observed time by sidereal chronometer	5 8 37.5	5 9 18.0	5 10 4.8	5 13 23.5	5 16 13.2	5 19 10.2	
App. noon by sidereal chronometer	2 25 48.9	2 25 49.6	2 25 49.4	2 25 48.8	2 25 48.8	2 25 48.9	
Sun's A. R. at app. noon	23 30 7.5	23 30 7.5	23 30 7.5	23 30 7.5	23 30 7.5	23 30 7.5	*h. m. s.*
Error of chronometer at app. noon	—2 55 41.4	—2 55 42.1	—2 55 41.9	—2 55 41.3	—2 55 41.3	—2 55 41.4	—2 55 41.6

Circum-meridian altitudes of α Argus, March 6, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Sidereal Chronometer, by Bond & Sons, No. 202; Computer, L. Daser.

Observed— Circum-meridian altitudes.	Observed— Time by chronometer.	Meridian distance.	k.	m.	Reduction to the meridian.	Circum-meridian altitudes corrected for refraction and index error.	True meridian altitudes deduced.	Latitude.
° ′ ″	h. m. s.	m. s.	″		′ ″	° ′ ″	° ′ ″	° ′ ″
29 14 55	9 8 6.2	8 41.2	148.0	0.05	1 42.0	29 15 19	29 17 1.0	8 5 39.0
29 15 45	9 11 22.0	5 25.4	57.8	0.01	39.9	29 16 9	29 16 48.9	8 5 51.1
29 16 10	9 12 39.5	4 7.9	33.5	0.00	23.1	29 16 34	29 16 57.1	8 5 42.9
29 16 25	9 15 21.5	1 25.9	4.0	0.00	2.8	29 16 49	29 16 51.8	8 5 48.2
M. P.	9 16 47.4							
29 16 25	9 18 22.8	1 35.4	4.9	0.00	3.4	29 16 49	29 16 52.4	8 5 47.6
29 16 15	9 20 15.5	3 28.1	23.6	0.00	16.3	29 16 39	29 16 55.3	8 5 44.7
29 16 5	9 21 21.0	4 33.6	40.8	0.00	28.2	29 16 29	29 16 57.2	8 5 42.7
29 15 45	9 22 31.0	5 43.6	64.4	0.01	44.4	29 16 9	29 16 53.4	8 5 46.6
29 15 25	9 23 41.0	6 53.6	93.3	0.02	1 4.4	29 15 49	29 16 53.4	8 5 46.6
29 14 45	9 25 38.8	8 51.4	154.0	0.06	1 46.3	29 15 9	29 16 55.3	8 5 44.7
29 13 50	9 27 45.2	10 57.8	236.0	0.14	2 42.8	29 14 14	29 16 56.8	8 5 43.2
29 13 5	9 29 04.5	12 17.1	296.3	0.21	3 24.2	29 13 29	29 16 53.2	8 5 46.8
29 15 24.2					1 6.5	29 15 48.2	29 16 54.7	8 5 45.3

Refraction	=—	1′ 44″
Index error	=+	2 08
	=+	24″

Approx. latitude	8°	5′	00″	Cos.	=	9.99566
Declination	—52	37	20	Cos.	=	9.78324
Appx. A.	29	17	40	Sin.		0.05941
		0.689				9.83831

Station—Turbo.

Circum-meridian altitudes of γ Ursæ Majoris, March 6, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Sidereal Chronometer, by Bond & Sons, No. 202; Computer, L. Daser.

Observed— Circum-meridian altitude.	Observed— Time by chronometer.	Meridian distance.	k.	m.	Reduction to the meridian.	Circum-meridian altitudes corrected for refraction and index error.	True meridian altitudes deduced.	Longitude.
° ′ ″	h. m. s.	m. s.	″		″	° ′ ″	° ′ ″	° ′ ′
43 34 15	2 41 32.5	49.9	1.4	0.00	1.1	43 35 22	43 35 23.1	8 4 14.0
M. P.	2 42 22.4	0.0						
43 34 5	2 43 22.5	1 00.1	2.0	0.00	1.6	43 35 12	43 35 13.6	8 4 04.5
43 34 10			1.7	0.00	1.3	43 35 17	43 35 18.3	8 4 09.2

Refraction $= -1' \ 1''$
Index error $= +2 \ 8$
$+1 \ 7$

Appx. lat. =	8°	5′	00	Cos. =	9.99566
Decl. = +	54	28	50.9	Cos. =	9.76413
Appx. alt.	43	36	9	Sec. =	0.14016
			0.79		9.89995

Circum-meridian altitudes of ε Canis Majoris, March 7, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Sidereal Chronometer, by Bond & Sons, No. 202; Computer, L. Daser.

Observed— Circum-meridian altitudes.	Observed— Time by chronometer.	Meridian distance.	k	m.	Reduction to the meridian.	Circum-meridian altitudes corrected for refraction and index error.	True meridian altitudes deduced.	Latitude.
M. P.	h. m. s. 9 49 00.5							
° ′ ″		m. s.			′ ″	° ′ ″	° ′ ″	° ′ ″
52 46 10	10 9 46.5	20 46.0	846.1	1.76	20 18.5	52 47 34	53 7 52.5	8 5 6.0
52 41 30	10 11 59.0	22 58.5	1035.5	2.61	24 50.0	52 42 54	53 7 44.0	8 5 14.5
52 37 40	10 13 38.5	24 38.0	1190.3	3.45	28 31.5	52 39 4	53 7 35.5	8 5 23.0
52 41 46.7			1024	2.61	24 33.3	52 43 10.7	53 7 44	8 5 14.5

Refraction = − 44″
Index error = + 2 8
+ 1 24

Approx. lat. =	8°	5′ 00″	Cos. = 9.99566
Decl. =	− 28	47′ 1.5	Cos. = 9.94273
Approx. alt.	53	7 59	Sec. = 0.22188
		1.446	0.16027
			0.32054
			0.12499
		2.79	0.44553

Station—Turbo.

Circum-meridian altitudes of α Argus, March 8, 1858; Observer, Lieutenant N. Michler; Sextant by Pistor & Martins, No. 933; Sidereal Chronometer by Bond & Sons, No. 202; Computer, L. Daser.

Observed— Circum-meridian altitudes.	Observed— Time by chronometer.	Meridian distance.	k.	m.	Reduction to the meridian.	Circum-meridian altitudes corrected for refraction and index error.	True meridian altitudes deduced.	Latitude.
° ′ ″	h. m. s.	m. s.	″		′ ″	° ′ ″	° ′ ″	° ′ ″
M. P.	9 16 43.0							
29 16 15	9 19 22.5	2 39.5	13.9	0.00	9.7	29 16 39	29 16 48.7	8 5 51.3
29 16 5	9 21 00.0	4 17.0	36.0	0.00	24.8	29 16 29	29 16 53.8	8 5 46.2
29 15 40	9 22 43.5	6 0.5	70.9	0.01	49.9	29 16 4	29 16 52.9	8 5 47.1
29 14 55	9 24 33.7	7 50.7	120.8	0.04	1 23.4	29 15 19	29 16 42.4	8 5 57.6
29 14 0	9 26 52.0.	10 9.0	202.2	0.10	2 19.5	29 14 24	29 16 43.5	8 5 56.5
29 13 5	9 28 37.5	11 54.5	278.4	0.18	3 12.1	29 13 29	29 16 41.1	8 5 58.9
29 15 0	....	....	....	....	1 23.1	29 15 24	29 16 47.1	8 5 52.9

	′ ″
Refraction	= − 1 44
Index error	= + 2 8.0
	+ 24

	° ′ ″	
Approximate latitude	= 8 5 0	Cos. = 9.99566
Declination	= 52 37 20.1	Cos. = 9.78324
Approximate altitude	= 29 17 40	Sec. = 0.05941
	0.689	9.83831
	(0.26)	

Station—Hondo.

Date.	No. and kind of observation.	Sidereal chronometer, No. 202.	Sidereal chronometer, No. 196.	Mean time chronom. No. 6220.			
		h. m. s.	h. m. s.				° ′ ″
1858, Feb. 25	3. Alt. of α Can. Maj. (E.)	—2 58 3.9	—5 8 27.3	Broken.	1858, Feb. 25	10. Cir.-mer. alt. of α Aurigæ, (N.)	7 33 34.4
1858, Feb. 25	4. Alt. of α Tauri (W.)	—2 58 6.2	—5 8 27.3	Broken.	1858, Feb. 25	12. Cir.-mer. alt. of α Argus, (S.)	34.0

Station—Hondo.

Altitudes of α Can. Maj. (East) for time, February 25, 1858. Observer, Lieutenant N. Michler; Sextant by Pistor & Martins, No. 933; Sidereal Chronometer by Bond & Sons, No. 202; Computer, L. Daser. Assumed lat., 7° 33′ 30″; assumed long., +0° 40′ 52″ Washington Observatory.

	° ′ ″	° ′ ″	° ′ ″
Observed altitude (E.)	59 22 50	59 32 25	59 46 0
Index error	+ 2 0	+ 2 0	+ 2 0
Refraction	− 34	− 34	− 34
Correction	+ 1 26	+ 1 26	+ 1 26
True altitude = A	59 24 16	59 33 51	59 47 26
Latitude = L	7 33 30	7 33 30	7 33 30
North polar distance = Δ	106 31 31	106 31 31	106 31 31
2 m.	173 29 17	173 38 52	173 52 27
m.	86 44 38	86 49 26	86 56 13
m − A	27 20 22	27 15 35	27 8 47
Log. cos. m	8.75434	8.74356	8.72781
Log. sin. (m − A)	9.66206	9.66089	9.65921
Log. sec. (L)	0.00379	0.00379	0.00379
Log. cosec. Δ	0.01832	0.01832	0.01832
Log. sin.² ½ p	18.43851	18.42656	18.40913
Log. sin. ½ p	9.21925′	9.21328	9.20456′
	h. m. s.	h. m. s.	h. m. s.
Hour angle	1 16 17.1	1 15 14.2	1 13 43.9
*'s A. R.	6 38 54.9	6 38 54.9	6 38 54.9
Observed time by chronometer	8 20 41.8	8 21 45.8	8 23 13.5
Error of chronometer	−2 58 4.0	−2 58 5.1	−2 58 2.5
Mean			−2 58 3.9

Altitudes of α Tauri, (west) for time; February 25, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Sidereal Chronometer, by Bond & Sons, No. 202; Computer, L. Daser. Assumed latitude = 7° 33′ 30;″ assumed longitude = + 0° 4′ 52.″ Washington Observatory.

		° ′ ″		° ′ ″		° ′ ″		° ′ ″
Observed altitudes, (W)		57 31 45		57 13 20		56 47 45		56 23 25
Index error	+	2 0	+	2 0	+	2 0	+	2 0
Refraction	−	37	−	38	−	39	−	39
Correction	+	1 23	+	1 22	+	1 21	+	1 21
True altitude = A		57 33 8		57 14 42		56 59 6		56 24 46
Latitude = L		7 33 30		7 33 30		7 33 30		7 33 30
North polar distance = Δ		73 46 39		73 46 39		73 46 39		73 46 39
2 m		138 53 17		138 34 51		138 9 15		137 44 55
m		69 26 38		69 17 25		69 4 37		68 52 27
(m − A)		11 53 30		12 2 43		12 15 31		12 27 41
Log. cos. m		9.54546		9.54855		9.55280		9.55681
Log. sin. (m − A)		9.31401		9.31948		9.32699		9.33401
Log. sec. L		0.00379		0.00379		0.00379		0.00379
Log. cosec. − Δ		0.01765		0.01765		0.01765		0.01765
Log. (sin.² ½ p.)		18.88091		18.88947		18.90123		18.91226
Log. (sin. ½ p.)		9.44045′		9.44473′		9.45061′		9.45613′
		h. m. s.		h. m. s.		h. m. s.		h. m. s.
Hour angle		2 8 2.1		2 9 20.3		2 11 8.9		2 12 52.5
*'s A. R.		4 27 47.3		4 27 47.3		4 27 47.3		4 27 47.3
Observed time by chronometer		9 33 55.0		9 35 15.0		9 37 2.5		9 38 45.5
Error of chronometer	−	2 58 5.6	−	2 58 7.4	−	2 58 6.3	−	2 58 5.7
Mean							−	2 58 6.2

Station—Hondo.

Circum-meridian altitudes of *α* Aurigæ; February 25, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Computer, L. Daser; Sidereal Chronometer, by Bond & Sons, No. 202.

Observed—Circum-meridian altitudes.	Observed—Time, by chronometer.	Meridian distances.	*k.*	*m.*	Reduction to the meridian.	Circum-meridian altitudes corrected for refraction and index error.	True meridian altitudes deduced.	Latitude.
° ′ ″	*h. m. s.*	*m. s.*	″		′ ″	° ′ ″	° ′ ″	° ′ ″
51 39 15	7 57 34.0	6 44.5	89.2	0.02	1 38.6	51 40 29	51 42 7.6	7 33 19.9
51 40 5	7 58 57.5	5 21.0	56.2	0.01	1 2.1	51 41 19	51 42 21.1	7 33 33.4
51 40 35	8 0 7.0	4 11.5	34.4	0.00	38.0	51 41 49	51 42 27.0	7 33 39.3
51 41 10	8 2 40.0	1 38.5	5.2	0.00	5.8	51 42 24	51 42 29.8	7 33 42.1
51 41 10	8 4 1.0	17.5	0.2	0.00	0.2	51 42 24	51 42 24.2	7 33 36.5
M. P.	8 4 18.5	.0						
51 41 10	8 5 40.5	1 22.0	3.7	0.00	4.1	51 42 24	51 42 28.1	7 33 40.4
51 40 50	8 6 47.5	2 29.0	12.1	0.00	13.4	51 42 4	51 42 17.4	7 33 29.7
51 40 5	8 9 50.5	5 32.0	60.1	0.01	1 6.5	51 41 19	51 42 25.5	7 33 37.8
51 39 40	8 10 42.5	6 24.0	80.4	0.01	1 28.9	51 40 54	51 42 22.9	7 33 35.2
51 38 35	8 12 34.2	8 15.7	134.0	0.05	2 28.1	51 39 49	51 42 17.1	7 33 29.4
51 40 15.5					52.6	51 41 29.5	51.42 22.1	7 33 34.4

	h. m. s.
*'s A. R. .... =	5 6 13.5
Error of chro.... =	— 2 58 5.0
Merid'n passage =	8 4 18.5

	° ′ ″		
Assumed latitude...... =	7 33 30	Cos. =	9.99622
Declination	+ 45 51 12.3	Cos. =	9.84292
Approx. alt .... =	51 42 18	Sec. =	0.20781
	1.114	=	0.04695
			0.09390
		tg. ā =	0.10259
		1.57	0.19649

	″
Refraction... =	— 46.1
½ index error =	+ 2 0.0
Correction =	+ 1 14.0

Circum-meridian altitudes of α Argus, February 25, 1858. Observer, Lieutenant N. Michler; Sextant by Pistor & Martins, No. 933; Sidereal Chronometer by Bond & Sons, No. 202; Computer, L. Daser.

Observed— Circum-meridian altitudes.	Observed— Time by chronometer.	Meridian distances.	k.	m.	Reduction to the meridian.	Circum-meridian altitudes corrected for refraction and index error.	True meridian altitudes deduced.	Latitude.
° ′ ″	h. m. s.	m. s.			′ ″	° ′ ″	° ′ ″	° ′ ″
29 47 15	9 9 25.0	9 29.4	176.9	0.08	2 2.7	29 47 33.4	29 49 36.1	7 33 5.0
29 47 35	9 10 56.0	7 57.8	124.6	0.04	1 26.5	29 47 53.4	29 49 19.9	7 33 21.2
29 48 0	9 11 51.5	7 2.9	97.6	0.02	1 7.7	29 48 18.4	29 49 26.1	7 33 15.0
29 48 15	9 12 56.5	5 57.9	69.9	0.01	48.5	29 48 33.4	29 49 21.9	7 33 19.2
29 48 25	9 14 31.0	4 23.4	37.8	0.00	26.2	29 48 43.4	29 49 9.6	7 33 31.5
29 48 55	9 17 48.5	1 5.9	2.4	0.00	1.7	29 49 13.4	29 49 15.1	7 33 26.0
29 49 5	9 18 46.0	8.4	.0	0.00	0.0	29 49 23.4	29 49 23.4	7 33 17.7
M. P.	9 18 54.4	.0						
29 49 0	9 19 52.5	58.1	1.8	0.00	1.3	29 49 18.4	29 49 19.7	7 33 21.4
29 48 35	9 23 2.0	4 7.6	33.4	0.00	23.2	29 48 53.4	29 49 16.6	7 33 24.5
29 48 15	9 24 37.5	5 43.1	64.2	0.01	44.6	29 48 33.4	29 49 18.0	7 33 23.1
29 47 45	9 25 55.5	7 1.1	96.7	0.02	1 7.3	29 48 3.4	29 49 10.7	7 33 30.3
29 47 5	9 26 40.0	7 45.6	118.2	0.04	1 22.0	29 47 23.4	29 48 45.4	7 33 55.7
29 48 1	....	....	....	....	47.6	29 48 19.4	29 49 7.0	7 33 34.0

*'s A. R. = 6 20 49.4
Error of chronometer = − 2 58 5.0
Meridian passage = 9 18 54.4

		° ′ ″		
Assumed latitude	=	7 33 30	Cos. = 9.99622	
Declination	= −	52 37 18.9	Cos. = 9.78325	
Approx. A.	=	29 49 11	Sec. = 0.06168	
		0.694	= 9.38657	
			9.62830	
		tg. a	= 9.75827	
		0.24	= 9.38657	

		′ ″
Refraction	= −	1 41.6
½ index error	= +	2 0.0
Correction	= +	18.4

Station—Sucio.

Date.	No. and kind of observation.	Sidereal chronometer, No. 202.	Sidereal chronometer, No. 196	Mean time chronom., No. 6220.	Difference of Washington time.			
1858.		h. m. s.	h. m. s.		h. m. s.	1858.		° ′ ″
Feb. 21	Transit of 4 stars...............	−2 58 11.58	−5 8 32.3	Broken ...	....	Feb. 22	19. Cir.-mer. alt. of α Aurigæ (N.)	7 26 21.4
22	Transit of 7 stars..... ☾ 1......	8.00	5 8 29.4	Broken ...	+0 0 11.5	22	17. Cir.-mer. alt. of α Argus (S.).	11.9
23	Transit of 7 stars...............	5.13	5 8 27.4	Broken ...	....			

Station—Sucio.

Transit Observations, February 21, 1858. Observer, Lieutenant N. Michler; Zenith Telescope by Wurdemann, No. 11; Sidereal Chronometer by Bond & Sons, No. 202; Computer, L. Daser.

	α Can. Maj.	γ Can. Maj.	α² Geminorum.	β Geminorum.
Level (1 Div., 1″).	W. 11 E. 18	W. 14 E. 16	W. 8 E. 21	W. 14 E. 15
Level reversed.......	W. 11′ E. 18′	W. 15′ E. 15′	W. 9′ E. 20′	W. 14′ E. 15′
Wire I..............	....	....	....	10 34 12.5
Wire II..............	....	....	10 23 29.0	34 35.5
Wire III..............	9 37 12.0	9 55 38.0	23 53.5	....
Wire IV..............	37 31.8			
Wire V..............	37 52.8	....	....	....
Intervals..............	— 62.3	— 0.07	+ 23.23	+ 67.85
Mean wire..............	9 37 11.33	9 55 37.93	10 23 52.86	10 34 57.92
Rate..............	+ 0.50	+ 0.52	+ 0.56	+ 0.57
Level..............	— 0.23	— 0.03	— 0.43	— 0.02
Collimation..............	— 5.84	— 5.81	— 6.62	— 6.63
Az. deviation..............	+ 0.59	+ 0.56	— 0.69	— 0.57
*'s transit..............	9 37 6.35	9 55 33.17	10 23 45.68	10 34 51.27
*'s A. R..............	6 38 54.98	6 57 21.52	7 25 34.25	7 36 39.41
Reduc. to catalogue.	+ 0.21	— 0.07	+ 0.15	— 0.28
Error of chronom'r.	—2 58 11.58	2 58 11.58	2 58 11.58	2 58 11.58

Assumed error = 10 58 11.5. Equations of conditions.

		Δ	A	A²	A Δ	Az. Dev.
α Can. Maj.	58 10.78	+0.72	+0.424	+0.180	+0.305	+0.59
γ Can. Maj.	11.09	0.41	0.403	0.162	0.066	0.56
α² Geminor.	12.12	—0.62	—0.495	0.245	0.307	—0.69
β Geminor.	12.43	0.93	0.406	0.165	0.378	0.67
	....	—0.42	—0.074	+0.752	+0.056	....

$$4\,\epsilon - 0.074\,a = -0.42$$
$$-0.074\,\epsilon + 0.752\,a = +1.056$$
$$a = +1.396$$
$$\epsilon = -0.08$$

Chronometer error = — 2 58 11.58

Station—Sucio.

Transit Observations, February 22, 1858. Observer, Lieutenant N. Michler; Zenith Telescope by Wurdemann, No. 11; Sidereal Chronometer by Bond & Sons, No. 202; Computer, L. Daser.

	β Tauri.	χ Aurigæ.	☾^{1}	κ Aurigæ.	α Columbæ.	α Orionis.	α Can. Maj.	γ Can. Maj.
Level	W. 13 E. 9	W. 11 E. 10	W. 11 E. 14	W. 11 E. 14	W. 48 E. —11	W. 12 E. 12	W. 16 E. 10	W. 16 E. 10
Level reversed	W. 10′ E. 12′	W. 12′ E. 14′	W. 11′ E. 14′	W. 11′ E. 14′	W. 42′ E. — 4′	W. 11′ E. 13′	W. 16′ E. 10′	W. 19′ E. 6′
Wire I	8 14 47.5	8 20 56.0	8 59 9.5	9 43 8.2	8 31 58	8 45 03.5	9 36 27.5	9 54 55.0
Wire II	15 10.5	21 19.8	59 33.0	4 11.5	32 22.5	45 24.0	36 49.0	55 16.0
Wire III	15 33.5	21 34.2	59 56.5	4 34.2	32 46.8	45 44.0	37 10.0	55 36.0
Wire IV	15 55.8	22 06.2	9 0 19.8	4 57.5	33 10.8	46 04.0	37 30.0	55 56.5
Wire V	16 17.8	22 30.0	....	5 19.5	33 34.5	46 23.8	37 50.8	....
Eq. intervals	....	....	+ 46.35	....	....	....	....	+ 41.08
Mean wire	8 15 33.02	8 21 43.04	8 59 56.29	9 4 34.18	8 32 46.52	8 45 43.86	9 37 9.46	9 55 36.14
Rate	+ 0.40	+ 0.41	+ 0.45	+ 0.46	+ 0.42	+ 0.43	+ 0.50	+ 0.52
Level	0.03	0.00	— 0.11	— 0.11	+ 0.51	— 0.03	0.19	0.30
Collimation	— 6.37	— 6.61	— 6.38	— 6.44	— 6.75	— 5.64	— 5.84	— 5.81
Az. deviation	+ 0.98	+ 1.17	+ 0.98	+ 1.03	— 1.91	0.00	1.01	0.96
*'s transit	8 15 28.06	8 21 38.01	8 59 51.73	9 4 29.12	8 32 38.78	8 45 38.62	9 37 3.30	9 55 30.19
*'s A. R.	5 17 20.35	5 23 30.19	....	6 6 21.38	5.34 31.69	5 47 30.38	6 38 54.96	6 57 21.52
Reduction to the catalogue	+ 0.29	+ 0.18	....	+ 0.26	+ 0.91	— 0.24	— 0.34	— 0.67
Error of chronometer	2 58 8.00	2 58 8.00	....	2 58 8.00	2 58 8.00	2 58 8.00	2 58 8.00	2 58 8.00

February 22.—*Reduction of Transits by the method of least squares. Computer, L. Daser. Assumed error* = — 2 58 08.60.

		Δ	A	A²	A Δ	Az. Dev.	
θ Tauri	6.73	+ 1.87	— 0.409	+ 0.167	— 0.76	+ 0.98	$7\,\epsilon + 0.293\,\alpha = +3.51$
χ Aurigæ	6.65	+ 1.95	— 0.492	0.242	0.96	+ 1.17	$0.293\,\epsilon + 1.581\,\alpha = -3.60$
ι Aurigæ	6.71	+ 1.89	— 0.433	0.187	0.82	+ 1.03	$\alpha = -2.388$
α Columbæ	9.00	— 0.40	+ 0.802	0.643	0.32	— 1.91	$\epsilon = +0.60$
α Orionis	8.62	— 0.02	— 0.001	0.000	0.00	0.00	Error of chronometer = — 2 58 08.60.
α Can. Maj	9.35	— 0.75	+ 0.423	0.180	0.32	— 1.01	
γ Can. Maj	9.63	— 1.03	+ 0.403	0.162	0.42	— 0.96	
		+ 3.51	+ 0.293	1.581	3.60		

February 22.—*Moon Culmination.* *Observer L. N. Michler; Computer, L. Daser.*

I. Wire.......	8 59 09.5	
II. Wire.......	59 33.0	
III. Wire.......	59 56.5	
IV. Wire.......	9 0 19.8	1.59780
V. Wire.......	....	0.05645
	35 58 58.8	1.65425

45.11 s. = 11′ 16.65″
+ 1.24
46.35

+ 46.35

	35 59 45.15
Rate,	+ 0.45
Level,	— 0.11
Collimation,	— 6.38
Az. Dev.,	+ 0.98
Mean wire,	8 59 58.29
	8 59 51.23
	2 58 07.76
☾'s A. R.	6 1 43.46 at Sucio.
	6 1 42.92 at Washington.
	0.54

Log.................. 9.73239
Log. 3600.........=3.55630
3.28869
Log ☾ var. in A. R., =2.22799
1.06070
11.5 = 2′ 52.5″

Horizontal Parallax,	= 0° 59′ 21.1″	Sin. = 8.23713
Latitude,	= 7 26 14	Cos. = 9.99633
Interval in arc,	= 11 15.56	Sin. = 7.51594
Declination,	= 28 35 27	Sec. = 0.05645
Parallax in A. R.,	= + 0.88 s. = 13.2″	Sin. = 5.80585

Moon's var. in long..(log.) = (2.22799)
Interval ....(log.) = (1.65425)
3.88224
3600 s...(log.) = 3.55630
☾'s motion in A. R. = + 2.118 = 0.32594
Correction = + 1.24 s.

β Tauri..	2° 58′ 07.71″
χ Aurigæ..	07.82
κ Aurigæ..	07.74
	— 2 58 07.76

Station—Sucio.

Transit observations, February 23, 1858. Observer, Lieutenant N. Michler; Zenith Telescope, by Wurdemann, No. 11; Sidereal Chronometer, by Bond & Sons, No. 202; Computer, L. Daser.

	α Aurigæ.	β Tauri.	δ Orionis.	α Orionis.	γ Orionis.	γ Geminorum.	χ Aurigæ.
Level	W. 20 E. 24′	W. 25 E. 20	W. 23 E. 23	W. 22 E. 24	W. 29 E. 18	W. 26 E. 21	W. 26 E. 21
Level reversed	W. 22′ E. 23	W. 20′ E. 25′	W. 25′ E. 21′	W. 24′ E. 22′	W. 24′ E. 24′	W. 25′ E. 23′	W. 28′ E. 19′
Wire I	8 3 23.0	8 14 42.8	8 22 16.7	8 44 59.5			9 3 41.8
Wire II	3 51.8	15 5.7	22 37.5	45 20.0		9 27 21.0	
Wire III	4 20.8	15 28.5	22 57.2	45 40.5	8 57 39.0	27 41.5	4 30.5
Wire IV	4 49.5	15 51.2	23 16.8	46 0.2		28 2.0	4 51.8
Wire V	5 17.2	16 13.5	23 36.5	46 20.2		28 22.5	
Eq. intervals					+ 0.07	— 41.73	+ 22.87
Mean wire	8 4 20.46	8 15 28.34	8 22 56.94	8 45 40.08	8 57 39.07	9 27 41.32	9 4 28.99
Rate	+ 0.38	+ 0.40	+ 0.41	+ 0.43	+ 0.45	+ 0.49	+ 0.46
Level	— 0.09	0.00	+ 0.07	— 0.00	+ 0.19	+ 0.12	+ 0.25
Collimation	— 8.04	— 6.37	— 5.60	— 5.64	— 5.79	— 5.84	— 6.44
Az. deviation	+ 6.15	+ 2.88	0.96	0.00	+ 0.93	+ 1.16	+ 3.05
*'s transit	8 4 18.36	8 15 25.25	8 22 50.86	8 45 34.87	8 57 34.85	9 27 37.25	9 4 26.31
*'s A. R	5 6 13.60	5 17 20.34	5 24 46.32	5 47 30.36	5 59 29.26	6 29 32.04	6 6 21.36
Reduction to the catalogue	— 0.13	+ 0.22	+ 0.59	+ 0.62	— 0.46	— 0.08	+ 0.18
Error of chronometer	2 58 5.13	2 58 5.13	2 58 5.13	2 58 5.13	2 58 5.13	2 58 5.13	2 58 5.13

Station—Sucio.

February 23, 1858.—Reduction of Transits by the methods of least squares. Computer, L. Daser; Assumed Error, — 2 58 4.50.

		Δ	A	A²	A Δ	Az. dev.
α Aurigæ	7 59.11	+ 5.39	— 0.872	+ 0.760	— 4.70	+ 6.15
β Tauri	8 2.03	+ 2.47	0.409	0.167	— 1.01	+ 2.88
δ Orionis	8 5.50	— 1.00	0.136	0.018	— 0.14	— 0.96
ε Orionis	8 4.51	— 0.01	0.001	0.000	0.00	0.00
γ Orionis	8 4.66	— 0.16	0.132	0.017	+ 0.02	+ 0.93
γ Geminorum	8 4.05	+ 0.45	0.165	0.027	— 0.07	+ 1.16
χ Aurigæ	8 1.90	2.60	0.433	0.187	— 1.13	+ 3.05
		9.74	2.006	1.176	— 7.03	

$$7\epsilon - 2.006\,a = +9.74$$
$$-2.006\,\epsilon\,.7 + 1.176\,a = -7.03$$
$$a = -7.051$$
$$\epsilon = -0.63$$

Error of chronometer = — 2 58 5.13

933; Sidereal chronometer, by Bond & Sons, No. 202; Computer, L. Daser.

Observed— Circum-meridian altitudes.	Observed— Time by chronometer.	Meridian altitudes.	k.	m.	Reduction to the meridian.	Circum-meridian altitudes corrected for refraction and index error.	True meridian altitudes deduced.	Latitude.
° ′ ″	h. m. s.	m. s.	″		′ ″	° ′ ″	° ′ ″	° ′ ″
51 26 40	7 50 22.5	13 59.1	383.9	0.36	7 6.0	51 27 53.3	51 34 59.3	7 26 11.5
51 27 50	7 51 28.5	12 53.1	325.9	0.25	6 1.8	51 29 3.3	51 35 5.1	7 26 17.3
51 29 15	7 53 10.2	11 11.4	245.9	0.14	4 33.0	51 30 28.3	51 35 1.3	7 26 13.5
51 30 15	7 54 18.0	10 3.6	196.8	0.09	3 40.5	51 31 28.3	51 35 8.8	7 26 21.0
51 31 5	7 55 27.5	8 54.1	155.5	0.06	2 52.5	51 32 18.3	51 35 10.8	7 26 23.0
51 31 45	7 56 24.5	7 57.1	124.1	0.04	2 17.8	51 32 38.3	51 35 16.1	7 26 28.3
51 32 25	7 58 14.0	6 7.6	73.7	0.01	1 21.9	51 32 38.3	51 35 0.2	7 26 12.4
51 33 10	7 59 40.5	4 41.1	43.1	0.00	47.9	51 34 33.3	51 35 11.2	7 26 23.4
51 33 25	8 0 42.0	3 39.5	26.3	0.00	29.2	51 34 38.3	51 35 7.5	7 26 19.7
51 33 45	8 1 32.8	2 48.8	15.5	0.00	17.2	51 34 58.3	51 35 15.5	7 26 27.7
51 33 50	8 2 42.0	1 39.6	5.4	0.00	6.0	51 35 3.3	51 35 9.3	7 26 21.5
51 34 0	8 3 33.5	48.1	1.3	0.00	1.4	51 35 13.3	51 35 14.7	7 26 2.69
51 34 2	8 4 20.5	1.1	0.0	0.00	0.0	51 35 15.3	51 35 15.3	7 26 27.5
M. P.	8 4 21.6	0.0						
51 33 50	8 5 34.5	1 12.9	2.9	0.00	3.2	51 35 3.3	51 35 6.5	7 26 18.7
51 33 35	8 7 21.5	2 59.9	17.7	0.00	19.7	51 34 48.3	51 35 8.0	7 26 20.20
51 33 20	8 8 25.8	4 4.2	32.5	0.00	36.1	51 34 33.3	51 35 9.4	7 26 21.6
51 33 0	8 9 25.5	5 3.9	50.4	0.01	56.0	51 34 13.3	51 35 9.3	7 26 21.5
51 32 25	8 10 58.0	6 36.4	85.7	0.02	1 35.2	51 33 38.3	51 35 13.5	7 26 25.7
51 31 45	8 12 14.0	7 52.4	121.7	0.04	2 15.1	51 32 58.3	51 35 13.4	7 26 25.6
51 32 4.3			100.5	0.05	1 51.6	51 33 17.6	51 35 9.2	7 26 21.4

	° ′ ″
*'s A. R .... =	5 6 13.6
Chro. error .... =	− 2 58 8.0
Meridian passage. =	8 4 21.6

	° ′ ″		
Assumed latitude... =	7 26 16.0	Cos. =	9.99633
Declination.......... =	+45 51 12.2	Cos. =	9.84292
Approx. latitude ... =	51 35 4.0	Sec. =	0.20666
	1.111	=	0.04591
	1.558	tg. ā =	0.09182
		=	0.10071
			0.19253

	′ ″
Refraction.... =	−0 46.7
Index error.. =	+2 0.0
Correction ... =	+1 13.3

STATION—SUCIO.—Circum-meridian altitudes of α Argus, February 22, 1858. Observer, Lieutenant N. Michler. Sextant, by Pistor & Martins, No. 933; Sidereal chronometer, by Bond & Sons, No. 202; Computer, L. Daser.

Observed— Circum-meridian altitudes.	Observed— Time by chronometer.	Meridian distances.	k.	m.	Reduction to the meridian.	Circum-meridian altitudes corrected for refraction and index error.	True meridian altitudes deduced.	Latitude.
° ′ ″	h. m. s.	m. s.	″		′ ″	° ′ ″	° ′ ″	° ′ ″
29 52 55	9 7 27.5	11 30.0	259.6	0.16	3 0.4	29 53 13.8	29 56 14.2	7 26 27.4
29 54 5	9 9 10.5	9 47.0	187.9	0.09	2 10.6	29 54 23.8	29 56 34.4	7 26 7.2
29 54 40	9 11 9.0	7 48.5	119.7	0.04	1 23.1	29 54 58.8	29 56 21.9	7 26 19.7
29 55 15	9 12 20.8	6 36.7	85.8	0.02	59.6	29 55 33.8	29 56 33.4	7 26 8.2
29 55 30	9 13 44.5	5 13.0	53.4	0.01	37.1	29 55 48.8	29 56 25.9	7 26 15.7
29 55 45	9 14 47.5	4 10.0	34.1	0.00	23.7	29 56 3.8	29 56 27.5	7 26 14.1
29 56 5	9 15 54.5	3 3.0	18.3	0.00	12.7	29 56 23.8	29 56 36.5	7 26 5.1
29 56 15	9 17 10.8	1 46.7	6.2	0.00	4.3	29 56 33.8	29 56 38.1	7 26 3.5
M. P.	9 18 57.5	0.0						
29 56 20	9 19 1.5	4.0	0.0	0.00	0.0	29 56 38.8	29 56 38.8	7 26 2.8
29 56 10	9 20 10.5	1 13.0	2.9	0.00	0.2	29 56 28.8	29 56 30.8	7 26 10.8
29 56 5	9 21 5.0	2 7.5	8.9	0.00	6.2	29 56 23.8	29 56 30.0	7 26 11.6
29 55 55	9 22 2.5	3 5.0	18.7	0.00	13.0	29 56 13.8	29 56 26.8	7 26 14.8
29 55 30	9 24 41.0	5 43.5	64.3	0.01	45.0	29 55 48.8	29 56 33.8	7 26 7.8
29 54 55	9 25 52.8	7 5.3	98.2	0.02	1 8.2	29 55 13.8	29 56 22.0	7 26 19.6
29 54 30	9 27 18.5	8 21.0	136.9	0.05	1 35.2	29 54 48.8	29 56 24.0	7 26 17.6
29 54 10	9 28 16.0	9 18.5	170.1	0.08	1 58.2	29 54 28.8	29 56 27.0	7 26 14.6
29 53 25	9 30 17.5	11 20.0	252.2	0.15	2 55.4	29 53 43.8	29 56 39.2	7 26 2.4
29 55 8.8			89.25	0.04	1 2.1	29 55 27.6	29 56 29.7	7 26 11.9

	° ′ ″
✱'s A. R ....=	6 20 49.5
Chro. error ....=	—2 58 8.0
Meridian passage..=	9 18 57.5

	° ′ ″
Assumed latitude...=	7 26 16.0
Declination...........=	—52 37 18.4
Approx. altitude....=	29 56 26.0
	0.6947

Cos. =	9.99633
Cos. =	9.78324
Sec. =	0.06221
=	9.84178
	9.68356
tg. α =	9.76040

	′ ″
Refraction.... =	—1 41.2
Half in. error =	+2 00.0
Correction ... =	+0 18.8

Station—First Camp on the Truandó.

Observations for time and latitude. Observer, Lieutenant N. Michler; Computer, L. Daser.

I.—FOR TIME.

Date.	Number and kind of observations.	Apparent noon.	Chronometer error.
		h. m. s.	h. m. s.
1858, January 2	2 pairs of corresponding altitudes	4 9 40.9	— 4 5 15.6
1858, January 3	4 pairs of equal altitudes	4 10 7.1	4 5 14.1
1858, January 6	2 pairs of equal altitudes	4 11 22.6	4 5 8.4
1858, January 6	4 pairs of corresponding altitudes	4 11 18.5	4 5 4.6

II.—FOR LATITUDE.

Date.	Number and kind of observation.	Latitude.
		° ′ ″
1858, January 3	6. Circum-meridian altitude	7 9 44.4
1858, January 6	14. Circum-meridian altitude	7 9 10.5
		7 9 27.5

Station—First Camp on the Truandó.

Corresponding altitudes of the sun, January 2, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Mean Solar Chronometer, by Arnold, No. 6220; Computer, L. Daser. Assumed latitude = 7° 9′ 25″ N.; assumed longitude = 0° 12′ 30″ west of Washington Observatory. Declination = — 22° 54′ 31″; double daily variation = + 664″; equation of time = + 4*m.* 25.3*s.*

Observed altitudes.	Observed by the chronometer.		$t. - t'.$	$\frac{t - t'.}{2.}$	Equation of equal altitude.	Correction for difference in altitude.	Apparent noon.	Equation of time.	Error of chron. of mean time at apparent noon.
	A. M. = t.	P. M. = t'.							
° ′ ″	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*s*	*m.*	*h. m. s.*	*m. s.*	*h. m. s.*
47 38 40	U. L. 2 6 0.0	L. L. 6 10 16.8	4 4 16.8	4 8 8.4	— 1.81	+ 1 34.6	4 9 41.2	4 25.3	— 4 5 15.9
47 48 15	U. L. 2 6 54.0	L. L. 6 9 20.8	4 2 26.6	4 8 7.5	— 1.81	1 35.0	4 9 40.7	4 25.3	— 4 5 15.4
			4 3 21.7	4 8 7.95	— 1.81	+ 1 34.8	4 9 40.9	4 25.3	— 4 5 15.6

EQUATION OF EQUAL ALTITUDES.

$t - t'. = 4\ 3\ 21.7.$

Log. A	= — 7.7453	Log. B	= + 7.6809	— 0.464
Log. δ	= + 2.8222	Log. δ	= + 2.8222	— 1.346
Log. tg. a	= + 9.0989	Log. tg. D	= — 9.6195	
	— 9.6664		— 0.1290	— 1.81 equation of equal altitude.

Correction for difference in altitudes, the lower limb having been taken P. M., at the corresponding altitude of the upper limb A. M.

I.—*Excess of altitude* = $d\ h$.

	° ′ ″	° ′ ″
h .... =	47 38 40	47 48 15
Sun's diameter......... = +	32 36.78	32 36.78
Diff. in refraction..... = —	1.00	— 0.99
$d\ h$ .... =	1955.78	1955.79

II.—*Correction for difference of Altitude.*

Log. $d\ h$	= 3.29132	3.29134
Log. cos. h	= 9.82849	9.82716
	3.11981	3.11850
Log. 30	= 1.47712	1.47712
Log. cos. a	= 9.99660	9.99660
Log. cos. D	= 9.96432	9.96432
Log. sin. t.	= 9.70592	9.70595
	1.14396	1.14399

$$a\ t = \frac{d\ h \cos. h.}{30 \cos a \cos D. \sin t.}$$

Equal altitudes of the sun, January 3, 1858. Observer, Lieutenant N. Michler; Sextant by Pistor & Martins, No. 933; Mean Solar Chronometer by Arnold, No. 6220; Computer, L. Daser. Assumed latitude = 7° 9′ 25″ N.; assumed longitude 0° 12′ 30″ W. of Washington Observatory; declination 22° 48′ 45″; double daily variation = +719″; equation of time = +4m. 53s.

Observed altitudes.	Observed time by chronometer.		$t - t'$	$\frac{t+t'}{2}$	Equation of equal altitudes.	Apparent noon.	Equation of time.	Error of chron. of mean time at apparent noon.
	A. M. = t.	P. M. = t'.						
° ′ ″	h. m. s.	h. m. s.	h. m. s.	h. m. s.	s.	h. m. s.	m. s.	h. m. s.
45 54 10	1 59 18.4	6 21 0.4	4 21 42.0	4 10 9.4	−1.94	4 10 7.46	4 53.0	−4 5 14.5
46 38 45	2 0 24.8	6 19 51.6	4 19 26.8	4 10 8.2	1.94	4 10 6.26	....	4 5 13.3
47 25 20	2 4 50.0	6 15 28.8	4 10 38.8	4 10 9.4	1.94	4 10 7.46	....	4 5 14.5
48 9 55	2 12 19.2	6 7 58.8	3 55 39.6	4 10 9.0	1.94	4 10 7.06	....	4 5 14.1
			4 11 51.8	4 10 9.0	−1.94	4 10 7.06	....	−4 5 14.1

EQUATION OF EQUAL ALTITUDES.

h. m. s.				
$t - t'$ = 4 11 51.8	Log. A	= − 7.7468	Log. B	= + 7.6776
	Log. δ	− + 2.8567	Log. δ	= + 2.8567
	Log. tg. a	= + 9.0989	Log. tg. D	= − 9.6239
		− 9.7024		− 0.1582
		− 0.504		− 1.440

Station—First Camp on the Truandó.

Equal altitudes of the sun, January 6, 1858. Observer, Lieutenant N. Michler: Sextant by Pistor & Martins, No. 933; Mean Solar Chronometer by Arnold, No. 6220; Computer, L. Daser. Assumed latitude = 7° 9′ 25″ N.: assumed longitude, 0° 12′ 30″ W. of Washington Observatory; declination = — 22° 28′ 45″; double daily variation = + 881″; equation of time = + 6*m*. 13.64*s*.

	Observed altitudes.	Observed time by chronometer. A. M. = t.	Observed time by chronometer. P. M. = t'.	$t - t'$.	$\frac{t + t'}{2}$.	Equation of equal altitudes.	Apparent noon.	Equation of time.	Error of chron. of mean time at apparent noon.
	° ′ ″	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*s.*	*h. m. s.*	*m. s.*	*h. m. s.*
Upper limb..	46 51 40	2 1 42.8	6 21 4.8	4 19 22.0	4 11 23.8	—2.34	4 11 21.46	6 13.64	—4 5 7.8
Lower limb..	46 51 40	2 4 48.8	6 18 1.2	4 13 12.4	4 11 25.0	2.34	4 11 22.66	6 13.64	4 5 9.0
				4 16 17.2	4 11 24.4	—2.34	4 11 22.06	6 13.64	—4 5 8.4

EQUATION OF EQUAL ALTITUDES.

$t - t' = 4^h\ 16^m\ 17^s.2$

Log. A	= — 7.7475	Log. B	= + 7.6758
Log. δ	= + 2.9450	Log. δ	= + 2.9450
Log. tg. a	= + 9.0989	Log. tg. D	= — 9.6168
	— 9.7914		— 0.2376
			— 1.725
	— 0.619		

Observed altitudes.	Observed time by chronometer. A. M. = t.	P. M. = t'.	$t - t'$.	$\frac{t+t'}{2}$	Equation of equal altitudes.	Correction for difference in altitudes.	Apparent noon.	Equation of time.	Error of chronometer of mean time at app. noon.
° ′ ″	h. m. s.	h. m. s.	h. m. s.	h. m. s.	s.	m. s.	h. m. s.	m. s.	h. m. s.
50 35 25	U. L. 2 23 22.4	L. L. 5 55 56.0	3 32 33.6	4 9 39.2	− 2.40	+ 1 40.92	4 11 17.72	6 13.64	− 4 5 4.1
50 46 50	2 24 31.6	5 54 46.0	3 30 14.4	4 9 38.8	2.40	1 46.55	4 11 18.02	6 13.64	4 5 4.4
51 1 25	2 26 6.0	5 53 10.8	3 27 4.8	4 9 38.4	2.41	1 42.45	4 11 18.44	6 13.64	4 5 4.8
51 57 40	2 32 2.8	5 47 6.8	3 15 4.0	4 9 34.8	2.42	1 46.13	4 11 18.51	6 13.64	4 5 4.9
			3 26 11.7						4 5 4.55

EQUATION OF EQUAL ALTITUDES.

Log A	= − 7.7403	− 7.7400	− 7.7396	− 7.7397
Log δ	= + 2.9450	+ 2.9450	+ 2.9450	+ 2.9450
Log tg. a	= + 9.0989	+ 9.0989	+ 9.0989	+ 9.0989
	− 9.7842	− 9.7839	− 9.7835	− 9.7818
	− 0.608	− 0.608	− 0.607	− 0.607
Log B	= + 7.6919	+ 7.6927	+ 7.6937	+ 7.6937
Log δ	= + 2.9450	+ 2.9450	+ 2.9450	+ 2.9450
Log tg. D	= − 9.6168	− 9.6168	− 9.6168	− 9.6168
	− 0.2537	− 0.2545	− 0.2555	− 0.2591
	− 1.794	− 1.797	− 1.801	− 1.816

CORRECTION FOR DIFFERENCE IN ALTITUDE.

I.—*Difference in Altitude.*

	° ′ ″	° ′ ″	° ′ ″	° ′ ″
h........................ =	50 35 25	50 46 50	51 1 25	51 57 40
Sun's diameter..... =	+ 32 36.6	+ 32 36.6	+ 32 36.6	+ 32 36.6
Diff. in refraction..	− 0.93	− 0.91	− 0.90	− 0.87
d h.................... =	+ 19 55.7	Same.	Same.	Same.

II.—*Correction in time for difference in Altitude.*

Log. 1955.7	= 3.29130	3.29130	3.29130	3.29130
Cos. h	= 9.80268	9.80092	9.79865	9.78972
	3.09398	3.09222	3.08995	3.08102
Log. 30	= 1.47712	1.47712	1.47712	1.47712
Cos. L	= 9.99660	9.99660	9.99660	9.99660
Cos. D	= 9.96568	9.96568	9.96568	9.96568
Sin. t	= 9.65059	9.64616	9.64005	9.61578
	1.08999	1.08556	1.07945	1.05518
	2.00399	2.00666	2.01050	2.02584
	+ 100.92	+ 101.55	+ 102.45	+ 106.13

Station—First Camp on the Truandó.

Circum-meridian altitudes of the Sun's Upper Limb, January 3, 1858. Observer, Lieut. N. Michler; Sextant by Pistor & Martins, No. 933; Mean Solar Chronometer by Arnold, No. 6220; Computer, L. Daser.

Observed— Circum-meridian altitudes.	Observed— Time by chronometer.	Meridian distances.	k.	m.	Reduction to the meridian.	Circum-meridian altitudes corrected for refraction and index error.	True meridian altitudes deduced.	Latitude.
° ′ ″	h. m. s.	m. s.			′ ″	° ′ ″	° ′ ″	° ′ ″
60 12 5	3 59 54.0	10 13.0	204.9	0.10	6 14.6	59 55 19	60 1 33.6	7 9 41.4
60 13 40	4 1 26.8	8 40.2	147.6	0.05	4 29.9	59 56 54	60 1 23.9	7 9 51.1
60 15 25	4 2 54.8	7 12.2	101.9	0.02	3 6.5	59 58 39	60 1 45.5	7 9 29.5
M.	4 10 7.0	00.0						
60 16 50	4 14 54.0	4 47.0	44.9	0.00	1 22.2	60 0 4	60 1 26.2	7 9 48.8
60 15 40	4 16 24.8	6.17.8	77.8	0.01	2 22.4	59 58 54	60 1 16.4	7 9 58.6
60 11 10	4 21 6.8	10 59.8	237.4	0.14	7 13.9	59 54 24	60 1 37.9	7 9 37.1
60 14 08.3	....		135.8	0.05	4 8.3	59 57 22.3	60 1 30.6	7 9 44.4

		′ ″
Semi-diameter	= −	16 18.4
Refraction	= −	33.4
Parallax	= +	4.0
Index error	= +	2.0
Correc. for altitude	= −	16 46

	° ′ ″		
Assumed latitude =	7 9 30	Log. cos. =	9.99660
Declination =	− 22 48 45	Log. cos. =	9.96467
Approx. Z. D. C. =	60 1 45	Log. sec. =	0.30142
Constant multiple for k		=	0.26269
		=	1.831
Log. tg. approx. alt.		=	0.23907
Constant multiple for m		=	0.76445
		=	5.94

Station—First Camp on Truando.

Circum-meridian altitudes of the Sun's upper limb, January 6, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Mean Solar Chronometer, by Arnold, No. 6220; Computer, L. Daser.

Observed— Circum-meridian altitudes.	Observed— Time by chronometer.	Meridian distances.	k.	m.	Reductions to the meridian.	Circum-meridian altitudes corrected for semi-diameter, refraction, parallax, and index error.	True meridian altitudes deduced.	Latitude.
° ′ ″	h. m. s.	m. s.			′ ″	° ′ ″	° ′ ″	° ′ ″
60 29 10	3 58 20.8	13 1.2	332.9	0.27	10 15.6	60 11 58.7	60 21 74.3	7 9 0.9
60 30 25	3 59 32.0	11 50.0	275.0	0.18	8 28.7	60 13 13.7	60 21 42.4	7 9 32.8
60 32 25	4 0 53.2	10 28.8	215.7	0.11	6 39.2	60 15 13.7	60 21 52.9	7 9 22.3
60 33 55	4 2 2.8	9 19.2	170.6	0.08	5 15.8	60 16 43.7	60 21 59.5	7 9 15.7
60 38 20	4 6 57.2	4 24.8	38.3	0.0	1 11.0	60 21 8.7	60 21 79.7	7 8 55.5
60 39 15	4 8 57.8	2 24.2	11.4	0.0	21.1	60 22 3.7	60 21 84.8	7 8 50.4
M.	4 11 22.0	0.0						
60 38 55	4 13 52.8	2 30.8	12.4	0.0	23.0	60 21 43.7	60 21 66.7	7 9 8.5
60 37 45	4 16 38.8	5 16.8	54.7	0.01	1 41.3	60 20 33.7	60 21 75.0	7 9 0.2
60 36 25	4 17 48.0	6 26.0	81.3	0.02	2 30.6	60 19 13.7	60 21 44.3	7 9 30.9
60 34 25	4 19 49.2	8 27.2	140.2	0.05	4 19.6	60 17 13.7	60 21 33.3	7 9 41.9
60 31 50	4 22 38.4	11 16.4	249.4	0.15	7 41.5	60 14 38.7	60 21 80.2	7 8 55.0
60 29 55	4 23 52.4	12 30.3	307.0	0.23	9 27.8	60 12 43.7	60 21 71.5	7 9 3.7
60 27 5	4 25 38.8	14 16.7	400.2	0.39	12 19.7	60 9 53.7	60 21 73.4	7 9 1.8
60 24 35	4 26 59.6	15 37.5	479.2	0.55	14 45.1	60 7 23.7	60 21 68.8	7 9 6.4
60 33 10.36			197.73	0.16	6 05.6	60 15 59.06	60 21 64.66	7 9 10.5

		′ ″
Semi-diameter,	= −	16 18.3
Refraction,	= −	33.0
Parallax,	= +	4.0
Index error,	= −	24.0
Correction for obs. alt.,	= −	17 11.3

		° ′ ″		
Assumed lat.,	=	7 9 30	Log. cos.,	= 9.99660
Declination,	= −	22 28 44.8	Cos.,	= 9.96568
App. altitude,	=	60 21 45	Sec.,	= 0.30583
			Constant multiple for k,	= 0.26811
Log. tang., approx. alt.,				= 0.24493
			Constant multiple for m,	= 0.78115

Station—Tocame.

Date.	Number and kind of observations.	Sid. Chron., No. 202.	Sid. Chron., No. 196.	Mean time Chron. No. 6220.			
1858.		*h. m. s.*	*h. m. s.*	*h. m. s.*	1858.		° ′ ″
January 10	2 pairs of equal alt. of the sun..	(Corked).......	(Corked).......	— 4 5 2.5	January 9	5. Circ. mer. alt. of α Argus (S.)	7 10 1.7
February 17	3 alt. of α Can. Maj. (east)	— 2 59 12.1	—5 9 23.3	4 3 38.8	January 10	11. Circ. mer. alt. of the Sun (S.)	9 50.6
February 17	3 alt. of α Arietis (west)..........	7.0			February 17	8. Circ. mer. alt. of α Argus (S.)	9 54.7
February 17	3 alt. of α Can. Min. (east)......	7.3					
February 17	5 alt. of α Tauri (west)............	9.6					

Station—Tocame.

Equal altitudes of the Sun, January 10, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Mean Solar Chronometer, by Arnold, No. 6220; Computer, L. Daser. Assumed latitude 7° 9′ 56″ N.; assumed longitude 0° 12′ 29″ west of Washington Observatory; declination = −21° 55′ 52″; double daily variation = + 1091″; equation of time + 7 m. 54.64 s.

Observed altitudes.	Observed time by chronometer. A. M. = t.	Observed time by chronometer. P. M = t'.	$t'-t$.	$\frac{t+t'}{2}$.	Equation of equal altitudes.	Apparent noon.	Equation of time.	Error of chronometer of mean time at apparent noon.
° ′ ″	h. m. s.	h. m. s.	h. m. s.	h. m. s.	s.	h. m. s.	m. s.	h. m. s.
40 45 40 U.	1 29 44.4	6 56 14.8	5 26 30.4	4 12 59.6	− 2.72	4 12 56.88	7 54.64	− 4 5 2.2
40 50 40 L.	1 32 32.8	6 53 27.6	5 20 54.8	4 13 0.2	2.73	4 12 57.47	7 54.64	4 5 2.8
				4 12 59.9	2.72	4 12 57.17	7 54.64	− 4 5 2.5

EQUATION OF EQUAL ALTITUDES.

Log. A.	= − 7.7621	− 7.7608		Log. B.	= + 7.6411	+ 7.6443
Log. δ.	= + 3.0378	+ 3.0378		Log. δ.	= + 3.0378	+ 3.0378
Log. tang. L.	= + 9.0994	+ 9.0994		Log. tang. D.	= − 9.6049	− 9.6049
	− 9.8993	− 9.8980			− .2838	− .2870
	− .793	− .792			− 1.923	− 1.937

Station—Tocame.

Altitudes of α Can. Maj. for time, February 17, 1858. Observer, Lieutenant N. Michler; Sextant by Pistor & Martins, No. 933; Sidereal Chronometer by Bond & Son, No. 202; Computer, L. Daser. Assumed latitude, 7° 9′ 56″ N.; assumed longitude, +0° 12′ 29″ Washington Observatory.

	° ′ ″	° ′ ″	° ′ ″
Observed altitude (E.)	55 38 45	55 53 15	56 9 15
Index error	+ 2 10	+ 2 10	+ 2 10
Refraction	− 0 40	− 0 40	− 0 39
Correction	+ 1 30	+ 1 30	+ 1 31
True altitude = A	55 40 15	55 54 45	56 10 46
Latitude = L	7 9 56	7 9 56	7 9 56
North polar distance = Δ	106 31 31	106 31 31	106 31 31
2 m	169 21 42	169 36 12	169 52 13
m	84 40 51	84 48 6	84 56 6
(m − A)	29 0 36	28 53 21	28 45 20
Log. cos. m	8.96713	8.95715	8.94590
Log. sin. (m − A)	9.68570	9.68405	9.68221
Log. sec. L	0.00341	0.00341	0.00341
Log. cosec. Δ	0.01832	0.01832	0.01832
Log. (sin.² ½ p)	18.67456	18.66293	18.64984
Log. (sin. ½ p)	9.33728	9.33146	9.32492
	h. m. s.	h. m. s.	h. m. s.
Hour angle	1 40 27.4	1 39 6.0	1 37 35.6
*'s right ascension	6 38 55.0	6 38 55.0	6 38 55.0
Observed time by chronometer	7 57 39.5	7 59 1.3	8 0 31.5
Error of chronometer	− 2 59 11.9	− 2 59 12.3	− 2 59 12.1
Mean			− 2 59 12.1

Altitudes of α Arietis (west) for time, February 17, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Sidereal Chronometer, by Bond & Son, No. 202; Computer, L. Daser. Assumed latitude, 7° 9′ 56″ N.; assumed longitude, + 0° 12′ 29″ Washington Observatory.

	° ′ ″	° ′ ″	° ′ ″
Observed altitude (W)	42 14 10	41 52 20	41 25 55
Index error	+ 2 10	+ 2 10	+ 2 10
Refraction	− 1 4	− 1 5	− 1 6
Correction	+ 1 6	+ 1 5	+ 1 4
True altitude = A	42 15 16	41 53 25	41 26 59
Latitude = L	7 9 56	7 9 56	7 9 56
North polar distance = Δ	67 12 31	67 12 31	67 12 31
2 m	116 37 43	116 15 52	115 49 26
m	58 18 51	58 7 56	57 54 43
(m − A)	16 3 35	16 14 31	16 27 44
Log. cos. m	9.72037	9.72260	9.72528
Log. sin. (m − A)	9.44191	9.44668	9.45237
Log. sec. L	0.00341	0.00341	0.00341
Log. cosec. Δ	0.03530	0.03530	0.03530
Log. (sin.² ½ p)	19.20099	19.20799	19.21636
Log. sin. ½ p	9.60049′	9.60399′	9.60818
	h. m. s.	*h. m. s.*	*h. m. s.*
Hour angle	3 7 54.3	3 9 31.1	3 11 28.0
*'s right ascension	1 59 10.4	1 59 10.4	1 59 10.4
Observed time by chronometer	8 6 10.5	8 7 48.5	8 9 46.5
Error of chronometer	− 2 59 5.8	− 2 59 7.0	− 2 59 8.1
Mean			− 2 59 7.0

Station—Tocame.

Altitudes of α Can. Min. (East) for time, February 17, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Sidereal Chronometer, by Bond & Son, No. 202; Computer, L. Daser. Assumed latitude, 7° 9′ 56″ N.; assumed longitude, + 0° 12′ 29″ Washington Observatory.

	° ′ ″	° ′ ″	° ′ ″
Assumed altitude (E)	56 2 15	56 58 50	57 21 45
Index error	+ 2 10	+ 2 10	+ 2 10
Refraction	− 0 39	− 0 38	− 0 37
Correction	+ 1 31	+ 1 32	+ 1 33
True altitude = A	56 3 46	57 0 22	57 23 18
Latitude = L	7 9 56	7 9 56	7 9 56
North polar distance = Δ	84 24 50	84 24 50	84 24 50
2 m	147 38 32	148 35 8	148 58 4
m	73 49 16	74 17 34	74 29 2
(m — A)	17 45 30	17 17 12	17 5 44
Log. cos. m	9.44505	9.43252	9.42733
Log. sin. (m — A)	9.48441	9.47298	9.46829
Log. sec. L	0.00341	0.00341	0.00341
Log. cosec A	0.00207	0.00207	0.00207
Log. (sin.² ½ p)	18.93504	18.91098	18.90110
Log. sin. ½ p	9.46752	9.45549	9.45055
	h. m. s.	h. m. s.	h. m. s.
Hour angle	2 16 30.8	2 12 40.4	2 11 7.2
*'s right ascension	7 31 53.7	7 31 53.7	7 31 53.7
Observed time by chronometer	8 14 30.5	8 18 20.0	8 19 54.0
Error of chronometer	− 2 59 7.6	− 2 59 6.7	− 2 59 7.5
Mean			− 2 59 7.3

Altitudes of α Tauri (West) for time, February 17, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Sidereal Chronometer, by Bond & Sons, No. 202; Computer, L. Daser. Assumed latitude, 7° 9′ 56″ N.; assumed longitude, +0° 12′ 29″ Washington Observatory.

	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
Observed altitude (W)	56 13 15	55 47 0	55 21 10	54 57 10	54 35 25
Index error	+ 2 10	+ 2 10	+ 2 10	+ 2 10	+ 2 10
Refraction	− 0 39	− 0 40	− 0 40	− 0 41	− 0 41
Correction	+ 1 31	+ 1 30	+ 1 30	+ 1 29	+ 1 29
True altitude = A	56 14 46	55 48 30	55 22 40	54 58 39	54 36 54
Latitude = L	7 9 56	7 9 56	7 9 56	7 9 56	7 9 56
North polar distance = Δ	73 46 39	73 46 39	73 46 39	73 46 39	73 46 39
2 m	137 11 21	136 45 5	136 19 15	135 55 14	135 33 29
m	68 35 40	68 22 32	68 9 37	67 57 37	67 46 44
(m − A)	12 20 54	12 34 2	12 46 57	12 58 58	13 9 50
Log. cos. m	9.56206	9.56646	9.57055	9.57432	9.57771
Log. sin. (m − A)	9.33011	9.33762	9.34490	9.35154	9.35742
Log. sec. L	0.00341	0.00341	0.00341	0.00341	0.00341
Log. cosec. Δ	0.01765	0.01765	0.01765	0.01765	0.01765
Log. ($\sin.^2 \frac{1}{2}$ p)	18.91323	18.92514	18.93651	18.94692	18.95619
Log. sin. $\frac{1}{2}$ p	9.45661′	9.46257	9.46825′	9.47346	9.47809′
	h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*
Hour angle	2 13 1.5	2 14 55.0	2 16 45.1	2 18 27.2	2 19 59.1
*'s right ascension	4 27 47.5	4 27 47.5	4 27 47.5	4 27 47.5	4 27 47.5
Observed time by chronometer	9 39 58.0	9 41 52.5	9 43 43.0	9 45 23.0	9 46 57.0
Error of chronometer	− 2 59 9.0	− 2 59 10.0	− 2 59 10.4	− 2 59 8.3	− 2 59 10.4
Mean					− 2 59 9.6

Station—Tocame.

Circum-meridian altitudes of α Argus, January 9, 1858. Observer, Lieutenant N. Michler; Sexant by Pistor & Martins, No. 933; Mean Solar Chronometer by Arnold, No. 6220; Computer, L. Daser.

Observed— Circum-meridian altitudes.	Observed— Time by chronometer.	Meridian distances.	k.	m.	Reduction to the meridian.	Circum-meridian altitudes corrected for refraction and index error.	True meridian altitudes deduced.	Latitude.
° ′ ″	h. m. s.	m. s.	″		′ ″	° ′ ″	° ′ ″	° ′ ″
30 13 10	3 8 17.2	3 57.1	30.6	0.00	21.4	30 12 20	30 12 41.4	7 10 11.4
30 14 15	3 11 14.8	59.5	2.0	0.00	1.4	30 13 25	30 13 26.4	7 9 26.4
M. P.	3 12 14.3	.0						
30 13 30	3 13 51.2	1 36.9	5.1	0.00	3.6	30 12 40	30 12 43.6	7 10 9.2
30 11 45	3 20 41.2	8 26.9	140.2	0.05	1 38.1	30 10 55	30 12 33.1	7 10 19.7
30 13 10					31.1	30 12 20	30 12 51.1	7 10 1.7

	h. m. s.
*'s A. R. sidereal time	= 6 20 50.33
*'s A. R. in mean interval	6 19 47.94
Mean time at the preceding sidereal 0h. at Greenwich,	4 48 13.44
Correction for difference in longitude	— 50.62
	4 47 22.8
Mean time of *'s A. R.	11 7 10.74
Chronometer error	— 4 5 3.6
Meridian passage	3 12 14.3

		° ′ ″		
Assumed latitude	=	7 9 56	Cos.	9.99659
Declination	—	52 37 7.2	Cos.	9.78327
Approx. altitude		30 12 57	Sec.	0.06342
			Log. i. =	0.00237
		0.7009	=	9.84565
				9.69130
			tg. ā. =	9.76520
		0.28		9.45650

		′ ″
Refraction	= —	1 40
½ index error	= +	50
Correction	—	50

Circum-meridian altitudes of the Sun's upper limb, January 10, 1858. Observer, Lieutenant N. Michler; Sextant by Pistor & Martins, No. 933; Mean Solar Chronometer by Arnold, No. 6220; Computer, L. Daser.

Observed—		Meridian distance.	k.	m.	Reduction to the meridian.	Circum-meridian altitudes corrected for semi-diameter, refraction, parallax, and index error.	True meridian altitudes deduced.	Latitude.
Circum-meridian altitudes.	Time by chronometer.							
° ′ ″	h. m s.	m. s.	″		′ ″	° ′ ″	° ′ ″	° ′ ″
61 7 20	4 5 56.8	7 0.4	96.4	0.02	3 2.3	60 51 23.7	60 54 26.0	7 9 41.9
61 8 35	4 7 12.0	5 45.2	65.0	0.01	2 3.0	60 52 38.7	60 54 41.7	7 9 26.2
61 8 55	4 8 14.4	4 42.8	43.6	0.00	1 22.5	60 52 58.7	60 54 21.2	7 9 46.7
61 9 35	4 11 38.8	1 18.4	3.3	0.00	6.2	60 53 38.7	60 53 44.9	7 9 23.0
M.	4 12 57.2	0.0						
61 10 30	4 13 8.8	11.6	0.1	0.00	0.2	60 54 33.7	60 54 33.9	7 9 34.0
61 10 15	4 14 2.0	1 4.8	2.3	0.00	4.4	60 54 18.7	60 54 23.1	7 9 44.8
61 9 15	4 16 12.7	3 15.5	20.8	0.00	39.4	60 53 18.7	60 53 58.1	7 9 69.8
61 7 50	4 18 31.2	5 34.0	60.8	0.01	1 55.0	60 51 53.7	60 53 48.7	7 9 79.2
61 7 20	4 19 22.4	6 25.2	80.9	0.01	2 33.1	60 51 23.7	60 53 56.8	7 9 71.1
61 5 25	4 22 8.0	9 10.8	165.5	0.06	5 12.9	60 49 28.7	60 54 41.6	7 9 26.3
61 4 0	4 23 13.2	10 16	206.9	0.11	6 30.9	60 48 3.7	60 54 34.6	7 9 33.3
61 8 5.4			67.78	0.02	2 8.2	60 52 9.1	60 54 17.3	7 9 50.6

	° ′ ″		
Declination.......	= 21 55 52.1	Cos.	= 9.96738
Assumed latitude..	= 7 9 56	Cos.	= 9.99659
Approx. altitude...	= 60 54 12	Sec.	= 0.31310
	1.8926		0.27707
		tg. App. A.	= 0.25452
	6.437		0.80816

		′ ″
Sun's semi-diameter	—	16 18.1
Refraction.............	—	32.2
Parallax	+	4
½ index error	+	50
Correction.............	—	15 56.3

Station—Tocame.

Circum-meridian altitudes of α Argus, February 17, 1858. Observer, Lieutenant N. Michler; Sextant by Pistor & Martins, No. 933; Sidereal Chronometer by Bond & Son, No. 202; Computer, L. Daser.

Observed— Circum-meridian altitudes.	Observed— Time by chronometer.	Meridian distances.	k.	m.	Reduction to the meridian.	Circum-meridian altitudes corrected for refraction and index error.	True meridian altitudes deduced.	Latitude.
° ′ ″	h. m. s.	m. s.	″		′ ″			° ′ ″
30 12 15	9 15 40	4 18.6	36.5	0.00	25.5	30 12 15.0	30 12 40.5	7 9 62.0
30 12 45	9 17 26	2 32.6	12.7	0.00	8.9	30 12 45.0	30 12 53.9	7 9 48.6
M. P.	9 19 58.6	.0						
30 13 5	9 20 2.5	39.9	.0	0.00	.0	30 13 5.0	30 12 65.0	7 9 37.5
30 12 40	9 21 46.5	1 47.9	6.4	0.00	4.5	30 12 40.0	30 12 44.5	7 9 58.0
30 12 20	9 24 26.8	4 28.2	39.3	0.00	27.4	30 12 20.0	30 12 47.4	7 9 55.1
30 11 50	9 26 5	6 6.4	73.3	0.00	51.1	30 11 50.0	30 12 41.1	7 9 61.4
30 11 15	9 27 54.5	7 55.9	123.6	0.04	1 26.1	30 11 15.0	30 12 41.1	7 9 61.4
30 12 18.7					29.1	30 12 18.7	30 12 47.8	7 9 54.7

	h. m. s.
*'s A. R.	= 6 20 49.6
Chronometer error......	— 2 59 9
Meridian passage.......	= 9 19 58.6

Assumed latitude.	= 7 9 54	Cos.	= 9.99659
Declination	52 37 17.5	Cos.	= 9.78324
Approx. altitude...	30 12 49	Sec.	— 0.06341
		0.697	9.84324
			9.68648
			9.76517
		0.28	9.45165

	′ ″
Refraction.......	= — 1 40
Index error.....	= + 1 40
Correction	= 0.00

Station—Tamoo.

Date.	No. and kind of observations.	Sidereal chronometer, No. 202.	Sidereal chronometer, No. 196.	Mean time chronometer, No. 6220.			
1858.		h. m. s.			1858.		° ′ ″
Feb. 2	4. Alt. of α Can. Maj. (East)......	—2 59 59.4	Left at Saltos.	No comparison.	Feb. 11	4. Circum-mer. alt. of α Argus.......	7 6 37.5
Feb. 12	3. Pairs of eq. alt. of the sun......	—3 0 25.3	Left at Saltos.	— 4h.4m.58.5s.			

Station—Tambo.

Altitudes of *α* Can. Maj. (East) for time, February 2, 1858. Observer, Lieutenant N. Michler; Sextant by Pistor & Martins, No. 933; Sidereal Chronometer by Bond & Sons, No. 202; Computer, L. Daser. Assumed latitude = 7° 6′ 40″ N.; assumed longitude + 0.29′ 4″ west of Washington Observatory.

	° ′ ″	° ′ ″	° ′ ″	° ′ ″
Observed altitude (E)	48 51 10	49 8 35	49 30 50	50 18 35
Index error	+ 1 40	+ 1 40	+ 1 40	+ 1 40
Refraction	− 51	− 51	− 50	− 48
	+ 49	+ 49	+ 50	+ 52
True altitude = A	48 51 59	49 9 24	49 31 40	50 19 27
Latitude = L	7 6 40	7 6 40	7 6 40	7 6 40
North Polar distance = Δ	196 31 28	196 31 28	196 31 28	196 31 28
2 *m*	162 30 7	162 47 32	163 9 48	163 57 35
m	81 15 3	81 23 46	81 34 54	81 58 47
m — A	32 23 4	32 14 22	32 3 14	31 39 20
Log. cos. *m*	9.18216	9.17493	9.16555	9.14469
Log. sin. (*m* — A)	9.72884	9.72710	9.72487	9.72001
Log. sec. L	0.00335	0.00335	0.00335	0.00335
Log. cosec = Δ	0.01832	0.01832	0.01832	0.01832
Log. (sin. $^2\frac{1}{2}$ *p*)	18.93267	18.92370	18.91209	18.88637
Log. sin. ½ *p*	9.46633′	9.46185	9.45604′	9.44318′
	h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*
Hour angle	2 16 7.7	2 14 41.4	2 12 50.9	2 8 52.1
*'s A. R.	6 38 55.2	6 38 55.2	6 38 55.2	6 38 55.2
Observed time by chronometer	7 22 46.0	7 24 11.5	7 26 3.0	7 30 6.0
Error of chronometer	− 2 59 58.5	− 2 59 57.7	− 2 59 58.7	− 2 59 62.9
Mean				− 2 59 59.4

Equal altitudes of the Sun, February 12, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Mean Solar Chronometer, by Arnold, No. 6220; Computer, L. Daser. Assumed latitude = 7° 6′ 40″ N.; assumed longitude = + 0° 29′ 4″, west of Washington Observatory; declination = − 13° 36′ 34.3″; double daily variation = + 2404″; equation of time = + 14m. 30s.06.

Observed altitudes.	Observed time by chronometer. A. M. = t.	Observed time by chronometer. P. M. = t'.	$t'. - t.$	$\frac{t. + t'.}{2}$	Equation of equal altitudes.	Apparent noon.	Equation of time.	Error of chronometer of mean time at apparent noon.
° ′ ″	h. m. s.	h. m. s.	h. m. s.	h. m. s.	s.	h. m s.	m. s.	h. m. s.
47 22 20	1 50 48.4	6 48 18.4	4 37 30.0	4 19 33.4		4 19 29.04		− 4 4 59.0
48 11 5	1 52 3.2	6 47 2.8	4 54 59.6	4 19 33.0	− 4.36	4 19 28.64	14 30.06	4 4 58.6
49 10 15	1 54 33.2	6 44 31.6	4 49 58.4	4 19 32.4		4 19 28.04		4 4 58.0
	1 52 28.3	6 48 37.6	4 54 9.3	4 19 32.93	....	4 19 28 57	....	− 4 4 58.5

EQUATION OF EQUAL ALTITUDES.

Log. A.	= − 7.7549	Log. B.	= + 7.6587
Log. δ.	= + 3.3809	Log. δ.	= + 3.3809
Log. tg. L.	= + 9.0960	Log. tg. D.	= + 9.3840
	− 0.2318		− 0.4236
	− 1.705		− 2.652

Station—Tambo.

Circum-meridian altitudes of α Argus, February 11, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Sidereal Chronometer, by Bond & Son, No. 202; Computer, L. Daser.

Observed— Circum-meridian altitudes	Observed— Time by chronometer.	Meridian distances.	k.	m.	Reduction to the meridian.	Circum-meridian altitudes corrected for refraction and index error.	True meridian altitudes deduced.	Latitude.
° ′ ″	h. m. s.	m. s.			m. s.	° ′ ″	° ′ ″	° ′ ″
30 14 5	9 13 0.0	8 15.0	139.6	0.05	1 33.5	30 14 17.6	30 15 51.1	7 6 52.6
30 15 30	17 47.0	3 28.0	23.6	0.00	16.5	30 15 42.6	30 15 59.1	7 6 44.6
30 16 5	21 5.5	9.5	0.1	0.00	0.1	30 16 17.6	30 16 17.1	7 6 26.0
M. P.	21 15.0	.0						
30 15 26	26 59.2	5 44.2	64.5	0.01	45.1	30 15 32.6	30 16 17.7	7 6 26.0
30 15 15	....	....	55.45	0.01	38.65	30 15 27.6	30 16 6.4	7 6 37.3

	h. m. s.
*'s A........................	= 6 20 50
Chronometer error......	= 3 0 25
Meridian passage.......	= 9 21 15

	° ′ ″	
Appr. lat. =	7 6 38	Cos. = 9.99665
Dist........ =	— 52 37 16.3	Cos. = 9.78325
Appr alt. =	30 16 6	Sec. = 0.06365
	0.697	= 9.84353
		9.68710
	tg. δ.	= 9.76616
	0.28	= 9.45326

	′ ″
Refraction... =	— 1 39.9
½ index error =	+ 1 52.5
Correction =	+ 12.6

Station—Pacific.

Date.	Number and kind of observations.	Sidereal chronometer No. 202.	Mean time chronometer No. 6220.			
1858.		h. m. s.	h. m. s.	1858.		° ′ ″
Feb. 8	7. Pairs of corresp. alt. of the sun	— 3 0 44.65	— 4 5 31.4	Feb. 8	10. Circ.-mer. alt. of α Argus	7 2 59.6

Station—Pacific.

Corresponding altitudes of the sun, February 8, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Mean solar chronometer, by Arnold, No. 6220; Computer, L. Daser. Assumed latitude, 7° 2′ 58″ N.; assumed longitude, 0° 37′ 40″ W. of Washington Observatory. Declination = — 14° 54′ 51″; double daily variation = + 2290; equation of time = + 14*m.* 28.05*s.*

Observed altitudes.	Observed time by chronometer. A. M. = t.	Observed time by chronometer. P. M. = t^1.	$t^1 - t$.	$\frac{t + t^1}{2}$.	Equation of equal altitudes.	Corr. for diff. in altitude.	Apparent noon.	Equation of time.	Error of chro. of mean time at appa'nt noon.
° ′ ″	*h. m. s.*	*h. m. s.*	*h. m. s.*	*h. m. s.*	*s.*	*s.*	*h. m. s.*	*m. s.*	*h. m. s.*
40 4 35	1 17 59.2	7 22 10.4	6 4 11.2	4 20 4.8			4 19 59.44		4 5 31.4
40 4 35	1 20 26.4	7 19 46.0	5 59 19.6	4 20 6.2			4 19 60.84		4 5 32.8
41 27 10	1 24 10.8	7 15 57.2	5 51 46.4	4 20 4.0			4 19 58.64		4 5 30.6
42 14 5	1 27 42.0	7 12 24.8	5 44 42.8	4 20 3.4	— 4.26	— 1.10	4 19 58.04	14 28.05	4 5 30.0
42 14 5	1 30 10.0	7 9 59.2	5 39 49.2	4 20 4.6			4 19 59.24		4 5 31.2
44 14 5	1 36 54.0	7 3 17.2	5 26 23.2	4 20 5.6			4 19 60.24		4 5 32.2
44 14 5	1 39 22.8	7 0 47.2	5 21 24.4	4 20 5.0			4 19 59.64		4 5 31.6
42 4 40			5 43 56.7	4 20 4.8	— 4.26	— 1.10	4 19 59.44	14 28.05	4 5 31.4

EQUATION OF EQUAL ALTITUDES.

Log A	= —	7.7663
Log δ	= +	3.3598
Log tang. L	= +	9.0922
	—	0.2183
	—	1.653
Log B	= +	7.6304
Log δ	= +	3.3598
Log tang. D	= —	9.4254
	—	0.4156
	—	2.604

CORRECTION FOR DIFFERENCE IN ALTITUDES.

Index error A. M. = + 1′ 45″   P. M. = 1′ 16″

Diff. in altitude = $d\ h$ = — 29

Log $d\ h$	= —	1.46240
Log cos. h	= +	9.87054
	—	1.33294
Log 30	=	1.47712
Log cos. L	=	9.99670
Log cos. D	=	9.98512
Log sin. t	=	9.83373
	+	1.29267
	—	0.04027
	—	1.097

Circum-meridian altitudes of α Argus, February 7, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Sidereal Chronometer, by Bond & Sons, No. 202; Computer, L. Daser.

Observed—		Meridian distances.	k.	m.	Reduction to the meridian.	Circum-meridian altitudes corrected for refraction and index error.	True meridian altitudes deduced.	Latitude.
Circum-meridian altitudes.	Time by chronometer.							
° ′ ″	° ′ ″	m. s.	″		′ ″	° ′ ″	° ′ ″	° ′ ″
30 17 50	9 10 26.5	11 8.8	244.0	0.15	2 50.6	30 16 55	30 19 45.6	7 2 58.9
30 18 15	9 11 50.0	9 45.3	186.8	0.08	2 10.6	30 17 20	30 19 30.6	7 2 73.9
30 20 20	9 18 20.0	3 15.3	20.7	0.00	14.5	30 19 25	30 19 39.5	7 2 65.0
30 20 15	9 20 8.5	1 26.8	4.1	0.00	2.8	30 19 20	30 19 22.8	7 2 81.7
*'s T.	9 21 35.3	.0						
30 19 58	9 24 35.5	3 0.2	17.7	0.00	12.4	30 19 3	30 19 15.4	7 2 89.1
30 15 5	9 37 36.5	16 1.2	503.7	0.61	5 51.5	30 14 10	30 19 61.5	7 2 43.0
30 13 55	9 39 13.0	17 37.7	609.8	0.90	7 5.7	30 13 0	30 19 65.7	7 2 38.8
30 11 50	9 41 16.0	9 40.7	759.8	1.40	8 50.0	30 10 55	30 19 45.0	7 2 59.5
30 10 35	9 42 57.5	21 22.2	896.0	1.94	10 25.0	30 9 40	30 19 65.0	7 2 39.5
30 8 55	9 44 30.0	22 54.7	1029.8	2.57	11 58.3	30 8 0	30 19 58.3	7 2 46.2
							30 19 44.9	7 2 59.6

		h. m. s.
*'s A. M.,	=	6 20 49.9
Chron. error,	=	—3 0 45.4
*'s transit by chron.,		9 21 35.3

	° ′ ″		
Assumed lat.,	= 7 3 0	Cos. =	9.99670
Declination,	= 52 37 15.5	Cos. =	9.78325
Appx. alt.,	= 30 19 45	Sec. =	0.06392
	0.698	=	9.84387
			9.68774
	tg. ā.		9.76719
	0.285	=	9.45493

	′ ″
Refraction	= — 1 39.9
Index error	= + 47.5
	— 55.0

Comparison of Sidereal Chronometers, Nos. 202 *and* 196; *Computer, L. Daser.*

Date.	No. 202.	No. 196.	Difference.
1858.—January 20, A. M	9 21 55.0	11 33 18.3	2 11 23.3
January 21, A. M	9 18 12.4	11 29 35.5	2 11 23.1
January 22, A. M	9 4 33.3	11 15 56.8	2 11 23.5
January 22, P. M	10 56 18.5	13 17 41.7	2 11 23.2
January 23, A. M	8 47 1.5	10 58 25.0	2 11 23.5
January 23, P. M	10 54 42.0	13 6 5.0	2 11 23.0
January 24, A. M	10 5 5.1	12 16 27.4	2 11 22.3
January 25, A. M	10 32 43.0	12 44 5.0	2 11 22.0
January 25, P. M	10 27 17.3	12 38 39.8	2 11 22.5
January 26, A. M	9 30 29.4	11 41 51.9	2 11 22.5
January 27, A. M	9 43 32.8	11 54 55.2	2 11 22.4
January 28, A. M	9 11 40.0	11 23 2.0	2 11 22.0
February 14, P. M	4 52 8.0	7 2 16.5	2 10 8.5
February 15, A. M	10 55 7.4	13 5 18.0	2 10 10.6
February 15, P. M	10 40 23.3	12 50 34.8	2 10 11.5
February 16, A. M	8 3 24.0	10 13 35.5	2 10 11.5
February 17, A. M	7 4 30.2	9 14 44.7	2 10 14.5
February 17, P. M	3 38 38.6	5 48 52.6	2 10 14.0
February 18, A. M	7 15 49.0	9 26 6.5	2 10 17.5
February 19, A. M	7 11 15.0	9 21 33.5	2 10 18.5
February 20, A. M	7 7 21.2	9 17 41.7	2 10 20.5
February 20, P. M	9 55 11.7	2 5 32.2	2 10 20.5
February 21, A. M	7 37 44.5	9 48 5.0	2 10 20.5
February 21, P. M	10 50 30.7	13 0 51.7	2 10 21.0
February 22, A. M	7 37 24.7	9 47 45.7	2 10 21.0
February 22, P. M	10 12 42.1	12 23 4.0	2 10 21.9
February 23, A. M	7 51 21.7	10 1 44.2	2 10 22.5
February 24, A. M	7 34 19.0	9 44 40.5	2 10 21.5
February 25, A. M	7 34 26.0	9 44 48.2	2 10 22.2
February 25, P. M	9 43 10.8	11 53 33.3	2 10 22.5
February 26, A. M	8 37 51.5	10 48 15.5	2 10 24.0
February 27, A. M	7 39 56.5	9 50 20.5	2 10 24.0
February 28, A. M	7 58 42.0	10 9 6.0	2 10 24.0
March 1, A. M	7 57 49.5	10 8 15.0	2 10 25.5
March 2, A. M	8 5 6.0	10 15 32.5	2 10 26.5
March 3, A. M	8 4 9.7	10 14 37.3	2 10 27.6
March 4, A. M	8 54 17.5	11 4 46.4	2 10 28.9
March 5, A. M	8 15 21.3	10 25 49.3	2 10 28.0
March 6, A. M	8 14 5.0	10 24 33.5	2 10 28.5
March 6, M	12 23 34.5	2 34 3.0	2 10 28.5
March 6, P. M	2 56 42.5	5 7 10.0	2 10 27.5
March 7, A. M	8 33 43.5	10 44 11.0	2 10 27.5
March 8, A. M	8 11 35.0	10 22 3.0	2 10 28.0
March 9, A. M	9 33 39.0	11 44 5.0	2 10 26.0
March 10, A. M	9 1 50.0	11 12 18.0	2 10 28.0
March 11, A. M	8 47 30.0	10 57 56.5	2 10 26.5
March 12, A. M	9 33 59.5	11 44 25.0	2 10 25.5

Errors and daily rates of Sidereal Chronometers, Nos. 202 and 196, by actual observations.

Computer, L. Daser.

Locality.	Date.	Error of chron. No. 202.	Difference of chronometers.	Error of chron. No. 196.	Daily rate of No. 202.	Daily rate of No. 196.
Saltos	1858, January 21	− 2 59 43.80	− 2 11 23.2	− 5 11 7.0		
Do	January 22	2 59 41.54	2 11 23.4	5 11 4.9	+ 2.26	+ 2.1
Do	January 23	2 59 40.23	2 11 23.3	5 11 3.5	1.31	1.5
Do	January 24	2 59 38.66	2 11 22.2	5 11 0.9	1.57	2.6
Do	January 25	2 59 36.33	2 11 22.2	5 10 58.5	2.33	2.4
Do	January 26	2 59 34.52	2 11 22.5	5 10 57.0	1.81	1.5
Do	January 27	2 59 33.35	2 11 22.3	5 10 55.6	1.17	1.4
Do	January 28	2 59 30.82	2 11 22.0	5 10 52.8	2.53	2.8
Do	February 15	2 59 57.21	2 10 10.6	5 10 7.8	− 1.46	2.5
Tocame	February 17	2 59 9.00	2 10 14.3	5 9 23.3		
Sucio	February 21	2 58 11.58	2 10 20.7	5 8 32.3		
Do	February 22	2 58 8.00	2 10 21.4	5 8 29.4	+ 3.58	2.9
Do	February 23	2 58 5.13	2 10 22.3	5 8 27.4	2.87	2.0
Hondo	February 25	2 58 5.05	2 10 22.3	5 8 27.3		
Turbo	March 6	2 55 58.3	2 10 28.5	5 6 26.8		
Do	March 7	2 55 56.6	2 10 27.6	5 6 24.2	1.7	2.6
Do	March 12	2 55 41.6	2 10 25.5	5 6 7.1	3.0	3.4

Errors and daily rates of Mean Time Chronometer, No. 6220, *deduced from the known errors of Sidereal Chronometer, No.* 202.

Computer, L. Daser.

Locality.	Date.	Sidereal time of comparison.	Mean time of comparison.	Mean time, chron. No. 6220.	Error of chron. No. 6220, of mean time.	Daily rate.
Saltos	1858, January 21, A.M.	18 18 13.3	22 15 25.11	26 20 30.0	— 4 5 4.9	....
Do	January 22, "	18 8 40.2	22 1 57.66	26 7 0.0	4 5 2.3	+ 2.6
Do	January 23, "	17 43 34.0	21 32 59.67	25 38 0.0	4 5 0.3	2.0
Do	January 24, "	19 3 0.3	22 48 17.04	26 53 14.0	4 4 57.0	3.3
Do	January 25, "	19 30 49.1	23 12 5.37	27 17 0.0	4 4 54.6	2.4
Do	January 26, "	18 30 24.5	22 7 54.74	26 12 48.0	4 4 53.3	1.3
Do	January 27, "	18 43 26.7	22 16 58.91	26 21 50.0	4 4 51.1	2.2
Do	January 28, "	18 11 42.9	21 41 24.39	25 46 12.0	4 4 47.6	3.5
Do	February 15, "	16 47 22.4	19 6 31.33	23 10 54.8	4 4 23.5	1.3
Tocame	February 17, P.M.	0 22 12.0	2 32 14.63	6 35 53.4	4 3 38.8	....

Errors of Sidereal Chronometer, No. 202, *deduced from the known errors of Mean Time Chronometer, No.* 6220.

Computer, L. Daser.

Locality.	Date.	Mean time of comparison.	Sidereal time of comparison.	Sidereal chron. No. 202.	Error of sidereal chronometer No. 202.	Daily rate.
		h. m. s.				
Pacific	1858, February 8, A.M.	7d 18 38 24.6	15 51 35.35	18 52 20.0	— 3 0 44.65	....
Tambo	February 12, "	11d 18 11 44.3	15 40 36.70	18 41 2.0	— 3 0 25.30	....

Mean daily rates of Sidereal Chronometer, No. 202, for the different periods of travel and rest.

Computer, L. Daser.

Locality.	Date.	Error of chronometer of local time.	Difference of errors.	Number of days.	Mean daily rate during the period.	Remarks.
Saltos	1858. Jan. 21	—2 59 43.80	*m. s.*			Chronometer at rest.
Do	28	2 59 30.82	+ 12.98	7	+ 1.85	
Saltos	Jan. 28	2 59 30.82				Chronometer carried by hand across the Cordilleras and back.
Do	Feb. 15	2 59 57.21	— 26.39	18	— 1.47	
Saltos	Feb. 15	2 59 57.21				Chronometer carried by canoe from Saltos to Sucio. The difference in longitude by moon culminations.
Sucio	21	2 58 11.58	+1 45.63			
Difference in longitude between Saltos and Sucio			1 18.99			
			+ 26.64	6	+ 4.44	
Sucio	Feb. 21	2 58 11.58				Chronometer at rest.
Do	23	2 58 5.13	+ 6.45	2	+ 3.22	
Turbo	Mar. 6	2 55 58.3				Chronometer at rest.
Do	12	2 55 41.6	+ 16.70	6	+ 2.78	

Mean daily rates of Chronometer, No. 196, for the different periods of travel and rest.

Computer, L. Daser.

Locality.	Date.	Error of chronometer of local time.	Difference of errors.	Number of days.	Mean daily rate during the period.	Remarks.
Saltos	1858. Jan. 21	—5 11 7.0	*m. s.*			Chronometer at rest.
Do	Feb. 15	5 10 7.8	+ 59.2	25	+ 2.37	
Saltos	Feb. 15	5 10 7.8	+1 35.5			Chronometer carried by canoe from Saltos to Sucio. The difference in longitude by moon culminations.
Difference in longitude			1 18.99			
Sucio	Feb. 23	5 8 32.3	+ 16.51	6	2.75	
Sucio	Feb. 21	5 8 32.3				Chronometer at rest.
Do	23	5 8 27.4	+ 4.9	2	2.45	
Turbo	Mar. 6	5 6 26.8				Chronometer at rest.
Do	12	5 6 7.1	+ 19.7	6	3.28	

Mean daily rates of Mean Time Chronometer, No. 6220, for the different periods of travel and rest.

Computer, L. Daser.

Locality.	Date.	Error of chronometer of local time.	Difference of errors.	Number of days.	Mean daily rate during the period.	Remarks.
		h. m. s.	m. s.			
First Camp on Truandó	1858. Jan. 3	—4 5 14.1				
Do	6	4 5 8.4	+ 5.7	3	+ 1.9	Chronometer at rest.
Saltos	Jan. 21	4 5 4.9				
Do	28	4 4 47.6	17.3	7	2.47	Chronometer at rest.
Saltos	Jan. 28	4 4 47.6				Chronometer carried by hand across the Cordilleras to the Pacific and back.
Do	Feb. 15	4 4 23.5	24.1	18	1.34	
Tocame	Jan. 10	4 5 2.5				Chronometer carried by canoe to the Saltos and back to Tocame. The rate from January 21 to February 15 being known, and of a different character, (7 days chronometer at rest and 18 carried by hand,) is deducted, in order to get the canoe rate.
Do	Feb. 17	4 3 38.8	1 23.7	38		
Difference from Jan. 21 to Feb. 15			41.4	25		
			42.3	13	3.25	

Difference in longitude between Turbo and Sucio.

Computer, L. Daser.

		s.	h. m. s.	
Observed rate of chronometer No. 202, from February 21 to 23		+ 6.45		2 days at Sucio.
Observed rate of chronometer No. 202, from March 6 to 12		+ 16.70		6 days at Turbo.
Concluded rate from February 23 to March 12		+ 31.83		11 days bet. Sucio and Turbo.
Observed error of chronometer at Sucio, February 23	= −		2 58 5.13	
Rate from February 23 to March 6	= +		31.83	
Concluded error of chronometer at Sucio, March 6	= −		2 57 33.3	
Observed error of chronometer at Turbo, March 6	= −		2 55 58.3	
Difference in longitude	= −		1 35.0	
			° ′ ″	
Longitude of Sucio	= +		77 5 40.5	west of Greenwich.
Difference between Sucio and Turbo	−		0 23 45.0	
Longitude of Turbo	+		76 41 55.5	

Difference in longitude between Saltos and Tocame.

Computer, L. Daser.

		h. m. s.	
Rate of chronometer No. 202, from February 15 to 21	= +	0 0 26.64	6 days.
Observed error of chronometer at Saltos, February 15	= −	2 59 57.21	
Rate from February 15 to 17	= +	8.88	2 days.
Concluded error of chronometer at Saltos, February 17	= −	2 59 48.33	
Observed error of chronometer at Tocame, February 17	= −	2 59 9.05	
Difference in longitude		39.28	
Rate of chronometer No. 196, from February 15 to 21	= +	16.51	6 days.
Observed error of chronometer at Saltos, February 15	= −	5 10 7.8	
Rate of chronometer, from February 15 to 17	= +	5.5	2 days.
Concluded error of chronometer at Saltos, February 17	= −	5 10 2.3	
Observed error of chronometer at Tocame, February 17	= −	5 9 23.3	
Difference in longitude	=	39.0	
Mean result	=	39.14	
		° ′ ″	
Longitude of Saltos	=	77 25 25.35	
Difference between Saltos and Tocame		9 47.1	
Longitude of Tocame		77 15 38.25	

Difference in longitude between Saltos and Tambo.

Computer, L. Daser.

		h.	m.	s.	
Observed rate of chronometer No. 6220, from January 28 to February 15	=+			24.1	18 days.
Observed error of chronometer at Tambo, February 12	=−	4	4	58.5	
Concluded rate of chronometer, from February 12 to February 15	=+			4.02	3 days.
Concluded error of chronometer at Tambo, February 15	=−	4	4	54.48	
Observed error of chronometer at Salto, February 15	=−	4	4	23.50	
Difference of longitude				30.58	
Observed rate of chronometer No. 202, from January 28 to February 15	=−			26.39	18 days.
Observed error of chronometer at Tambo, February 12	=−	3	0	25.3	
Concluded rate of chronometer, from February 12 to February 15	−			4.41	3 days.
Concluded error of chronometer at Tambo, February 15	=	3	0	29.71	
Observed error of chronometer at Saltos, February 15	=−	2	59	57.21	
Difference of longitude				32.50	
Mean result				31.54	

		°	′	″
Longitude of Saltos	=+	77	25	25.35
Difference between Tambo and Saltos			7	53.10
Longitude of Tambo		77	33	18.45

Difference in longitude between Saltos and Pacific.

Computer, L. Daser.

		h.	m.	s.	
Observed rate of chronometer No. 6220, from January 28 to February 15	=+			24.1	18 days.
Observed error of chronometer at Pacific, February 8	=−	4	5	31.4	
Concluded rate of chronometer, from February 8 to February 15	=+			9.4	7 days.
Concluded error of chronometer at Pacific, February 15	=−	4	5	22.0	
Observed error of chronometer at Saltos, February 15	=−	4	4	23.5	
Difference in longitude				58.5	
Observed rate of chronometer No. 202, from January 28 to February 15	=−			26.39	18 days.
Observed error of chronometer at Pacific, February 8	=−	3	0	44.65	
Concluded rate of chronometer, from February 8 to February 15	=−			10.29	7 days.
Concluded error of chronometer at Pacific, February 15	=−	3	0	54.94	
Observed error of chronometer at Saltos, February 15	=−	2	59	57.21	
Difference in longitude				57.73	
Mean result				58.11	

		°	′	″
Longitude of Saltos	=+	77	25	25.35
Difference between Saltos and Pacific			14	31.65
Longitude of Pacific		77	39	57.0

Table of latitudes.

Computer, L. Daser.

Station.	Date.	Number and kind of observations.	Mean result of each set of observations.	Weight.	Result deduced from observation of objects. South of the zenith.	Result deduced from observation of objects. North of the zenith.	Latitude.
			° ′ ″		° ′ ″	° ′ ″	° ″ ″
Turbo	1858, March 6	12 circum-mer. alt. of α Argus..............	8 5 45.3	12/21			
	March 6	2 circum-mer. alt. γ Ursæ Major.........	8 4 9.2	1			
	March 7	3 circum-mer. alt. ε Can. Major..........	8 5 14.5	3/21			
	March 8	6 circum-mer. alt. α Argus.................	8 5 52.9	6/21	8 5 43.1	8 4 9.2	8 4 56.1
Hondo.	1858, February 25	10 circum-mer. alt. of α Aurigæ............	7 33 34.4	1	7 33 34.0	7 33 34.4	7 33 34.2
	February 25	12 circum-mer. alt. of α Argus............	7 33 34.0	1			
Sucio......................	1858, February 22	19 circum-mer. alt. of α Aurigne...........	7 26 21.4	1	7 26 11.9	7 26 21.4	7 26 16.6
	February 22	17 circum-mer. alt. of α Argus.............	7 26 11.9	1			
First Camp	1858, January 3	6 circum-mer. alt. of the Sun.............	7 9 44.4	1	7 9 27.5	....	7 9 27.5
	January 6	14 circum-mer. alt. of the Sun.............	7 9 10.5	1			
Tocame....................	1858, January 19	5 circum-mer. alt. of α Argus..............	7 10 1.7	5/24			
	January 10	11 circum-mer alt. of the Sun..............	7 9 50.6	11/24	7 9 54.6	....	7 9 54.6
	February 17	8 circum-mer. alt. of α Argus..............	7 9 54.7	8/24			
Saltos	1858, January 20	19 circum-mer. alt. of the Sun.............	7 4 30.6	1			
	January 24	8 circum-mer. alt. of α Aurigæ............	7 4 32.4	8/9	7 4 30.6	7 4 32.4	7 4 31.5
	January 26	1 meridian altitude of α Aurigæ...........	7 4 32.1	1/9			
Tambo	1858, February 11	4 circum-mer. alt. of α Argus..............	7 6 37.5	1	7 6 37.5	....	7 6 37.5
Pacific.....................	1858, February 8	10 circum-mer. alt. of α Argus..............	7 2 59.6	1	7 2 59.6	....	7 2 59.6

Geographical positions of principal points.

Computer, L. Daser.

Station.	Latitude north.	Longitude west of Greenwich.
	° ′ ″	° ′ ″
Turbo	+ 8 4 56.1	+ 76 41 55.5
Hondo	7 33 34.2	
Sucio	7 26 16.6	77 5 40.5
First Camp on Truandó	7 9 27.5	
Tocame	7 9 54.6	77 15 38.2
Saltos	7 4 31.5	77 25 25.3
Tambo	7 6 37.5	77 33 18.4
Pacific	7 2 59.6	77 39 57.0

Station—Saltos.

		Sidereal Chronometers.		Mean time Chronometer, No. 6220.	Differ. in time between Washington and Saltos.			
		No. 202.	No. 196.					
1858.		h. m. s.		h. m. s.	m. s.	1858.		° ′ ″
Jan. 21	Transit of 3 stars...............	—2 59 43.80	—5 11 7.0	—4 5 4.9		Jan. 20	19. Cir. mer. alt. of the Sun...	7 4 30.6
Jan. 22	Transit of 11 stars...............	41.54	5 11 4.9	4 5 2.3		Jan. 24	8. Cir. mer. alt. of α Aurigæ.	32.4
Jan. 23	Transit of 24 stars...............	40.23	5 11 3.5	4 5 0.3		Jan. 26	1. Meridian alt. of α Aurigæ.	32.1
Jan. 24	Transit of 13 stars	38.66	5 11 0.9	4 4 57.0				
Jan. 25	Transit of 12 stars and ☾ 1.	36.33	5 10 58.5	4 4 54.6	+ 1 30.39			
Jan. 26	Transit of 9 stars and ☾ 1.	34.52	5 10 57.0	4 4 53.3	1 30.63			
Jan. 27	Transit of 10 stars and ☾ 1.	33.35	5 10 55.6	4 4 51.1	1 27.63			
Jan. 28	Transit of 17 stars and ☾ 1.	30.82	5 10 52.8	4 4 47.6	1 33.31			
Feb. 15	Transit of 11 stars...............	57.21	5 10 7.8	4 4 23.5				
Feb. 15	5. Altitudes of the sun..........	....	....	4 4 21.8	1 30.49			

Station—Saltos.

Transit observations, January 21, 1858. Observer, Lieutenant N. Michler; Zenith Telescope by Wurdemann, No. 11; Sidereal Chronometer by Bond & Son, No. 202; Computer, L. Daser.

	α Can. Maj.	α² Geminorum.	α Can. Min.
Level	W. 15.5 E. 21.5	W. 17 E. 20	W. 14 E. 23
Level reversed	W′ 1.0 E′ 52.0	W′ 18 E′ 19	W′ 18 E′ 19
Wire I	9 37 53.0	10 24 49.0	....
Wire II	38 15.0	25 13.5	....
Wire III	38 53.0	25 36.5	....
Wire IV	38 56.0	26 0.5	10 32 01.05
Wire V	39 16.5	26 24.0	32 22.00
Eq. intervals	....	....	— 59.49
Mean wire	9 38 35.10	10 25 36.70	10 31 42.00
Rate	+ 0.50	+ 0.56	+ 0.56
Level	— 0.91	— 0.07	— 0.17
Collimation	— 5.84	— 6.62	— 5.63
Az. deviation	+ 10.28	— 12.46	+ 0.65
*'s transit	9 38 39.13	10 25 18.11	10 31 37.41
*'s A. R	6 38 55.21	7 25 34.30	7 31 53.73
Reduction to the catalogue	— 0.12	— 0.01	+ 0.12
Error of chronometer	2 59 43.80	2 59 43.80	2 59 43.80

AZIMUTHAL DEVIATION.

α² Geminorum. A′ = — 0.5017 A. R.′ 7 25 34.30 T′ = 10 25 30.57
α Can. Maj.... A = + 0.4180 A. R. 6 38 55.21 T = 9 38 28.85

— 0.9179 46 39.09 47 01.72
47 01.72

— 22.63

$$\frac{-\ 22.63}{-\ 0.9197} = +\ 24.60$$

α² Geminorum, Az. deviation... = (+ 24.6) (— 0.5017) = — 12.35
α Can. Maj., Az. deviation..... = (+ 24.6) (+ 0.4180) = + 10.28

α Can. Min.... A′ = + 0.0261 A. R.′ 7 31 53.73 T′ = 10 31 36.76
α² Geminorum. A = — 0.5017 A. R. 7 25 34.30 T = 10 25 30.57

+ 0.5278 6 19.43 6 06.19
6 06.19

+ 13.24

$$\frac{+\ 13.24}{+\ 0.5278} = +\ 25.05$$

α Can. Min., Az. deviation... = (+ 25.05) (+ 0.0261) = + 0.65
α² Geminorum, Az. deviation. = (+ 25.05) (— 0.5017) = — 12.58

α Can. Maj.	α² Geminorum.	α Can. Min.
+ 10.28	— 12.35	+ 0.65
	— 12.58	
	— 12.46	

Error of chronometer = — 2 59 43.80

Station—Saltos.

Transit observations, January 22, 1858. Observer, Lieutenant N. Michler; Zenith Telescope by Wurdemann, No. 11; Sidereal Chronometer by Bond & Son, No. 202; Computer, L. Daser.

	η Tauri.	27 Tauri.	ν Eridani.	α Tauri.	α Leporis.	α Columbæ.	α Orionis.	α Argus.
Level	W. 28 E. 12.5	W. 28 E. 12.5	W. 40.5 E. 0.5	W. 24.5 E. 12.5	W. 29 E. 15	W. 25.5 E. 18.5	W. 21 E. 23	W. 26 E. 19
Level reversed	W′ 25.5 E′ 15	W′ 25.5 E′ 15	W′ 37 E′ 4	W′ 22 E′ 15	W′ 39 E′ 5	W′ 21 E′ 23	W′ 20 E′ 24	W′ 25.5 E′ 18.5
Wire I	6 38 17.0	....	6 50 18.0	7 26 57.5	8 25 20.0	8 33 06.5	....	....
Wire II	38 39.5	6 40 19.5	50 39.0	27 18.5	25 41.5	33 31.0	....	....
Wire III	39 00.5	40 41.0	50 59.5	27 39.5	26 02.5	33 55.0	....	9 19 56.5
Wire IV	39 22.5	41 02.5	51 20.0	28 00.0	26 23.0	34 19.5	....	20 29.5
Wire V	39 43.5	41 23.5	51 40.0	28 20.5	26 43.5	34 43.5	8 47 58.0	21 01.0
Eq. intervals	....	− 43.67	....	....	....	....	− 39.94	− 1 38.38
Mean wire	6 39 0.60	6 40 40.71	6 50 59.30	7 27 39.20	8 26 02.10	8 33 55.10	8 47 18.06	9 19 56.21
Rate (+ 1.8 daily)	+ 0.27	+ 0.28	+ 0.29	+ 0.33	+ 0.41	+ 0.42	+ 0.43	+ 0.48
Level	+ 0.45	+ 0.45	+ 1.17	+ 0.32	+ 0.76	+ 0.07	− 0.10	+ 0.19
Collimation	− 6.11	− 6.11	− 5.77	− 5.83	− 5.89	− 6.76	− 5.64	− 9.22
Az. deviation	− 9.70	− 9.66	+ 11.46	− 5.16	+ 13.79	+ 24.72	− 0.17	+ 44.17
*'s transit	6 38 45.51	6 40 25.67	6 51 06.45	7 27 28.86	8 26 11.17	8 34 13.55	8 47 12.58	9 20 31.83
*'s A. R.	3 39 03.89	3 40 44.44	3 51 25.36	4 27 47.79	5 26 29.59	5 34 32.18	5 47 30.67	6 20 50.21
Red. to the catalogue	− 0.08	+ 0.31	+ 0.45	+ 0.47	− 0.04	+ 0.17	− 0.37	− 0.08
Error of chronometer	2 59 41.54	2 59 41.54	2 59 41.54	2 59 41.54	2 59 41.54	2 59 41.54	2 59 41.54	2 59 41.54

Station—Saltos.

Transit observations continued, January 22, 1858. Observer, Lieutenant N. Michler; Zenith Telescope, by Wurdemann, No. 11; Sidereal Chronometer, by Bond & Son, No. 202; Computer, L. Daser.

	α^2 Geminorum.	α Can. Min.	β Geminorum.
Level	W.21 E.242	W.22.5 E.22.4	W. 25 E. 20
Level reversed	W′22.5 E′21.5	W′23.5 E′21.5	W′ 27 E′ 18
Wire I	10 24 50.5	10 30 59.5	
Wire II	25 14.0	31 20.3	10 36 17.5
Wire III	25 37.5	31 40.0	36 39.5
Wire IV	26 1.0	32 0.5	37 2.5
Wire V	26 24.0	32 19.5	37 24.5
Equal intervals			— 45.47
Mean wire	10 25 37.40	10 31 40.0	10 36 39.63
Rate	+ 0.56	+ 0.57	+ 0.57
Level	— 0.05	+ 0.03	+ 0.24
Collimation	— 6.62	— 5.63	— 6.36
Az. deviation	— 15.59	+ 0.80	— 12.83
*'s transit	10 25 15.70	10 31 35.77	10 36 21.25
*'s A. R.	7 25 34.30	7 31 53.73	7 36 39.42
Reduc. to the catalogue	+ 0.14	— 0.50	— 0.29
Error of chronometer	2 59 41.54	2 59 41.54	2 59 41 54

REDUCTION OF TRANSITS BY THE METHOD OF LEAST SQUARES.
Assumed error = — 2h. 59m. 41.6s.

Name of *.	Δ.	A.	A².	AΔ.	Az. Dev.
η Tauri	— 9.72	— 0.312	+ 0.097	+ 3.033	— 9.70
27 Tauri	— 9.29	— 0.311	0.097	2.889	— 9.66
γ Eridani	+ 11.97	+ 0.369	0.136	4.417	+ 11.46
α Tauri	— 4.63	— 0.166	0.028	0.769	— 5.16
α Leporis	+ 13.81	+ 0.444	0.197	6.132	+ 13.79
α Columbæ	+ 24.95	+ 0.796	0.634	19.860	+ 24.72
α Orionis	— 0.48	— 0.005	0.000	0.002	— 0.17
α Argus	+ 44.15	+ 1.422	2.022	62.781	+ 44.17
α^2 Geminorum	— 15.39	— 0.502	0.252	7.726	— 15.59
α Canis Minoris	+ 0.36	+ 0.026	0.001	0.009	+ 0.80
β Geminorum	— 13.06	— 0.413	0.171	5.394	— 12.83
	+ 95.24	+ 3.057	+ 3.635	+ 113.012	
	— 52.57	— 1.709			
	+ 42.67	+ 1.348			

$$11\,\epsilon + 1.348\,a = +\ 42.67$$
$$1.348\,\epsilon + 3.635\,a = +\ 113.012$$
$$\epsilon = \frac{42.67 - 1.348\,a}{11} = \frac{113.012 - 3635\,a}{1.348}$$
$$57.519 - 1.817\,a = 1243.132 - 39.985\,a$$
$$+\ 38.168\,a = +\ 1185.613$$
$$a = +\ 31.063$$
$$\epsilon = +\ 0.07$$
$$E = -\ 2h.\ 59m.\ 41.53s.$$

Station—Saltos.

Transit Observations, January 23, 1858. Observer, Lieutenant N. Michler; Zenith Telescope by Wurdemann, No. 11; Sidereal Chronometer, by Bond & Son, No. 202; Computer, L. Daser.

	17. Tauri.	μ Tauri.	27. Tauri.	γ Eridani.	o' Eridani.	2. Tauri.	α Tauri.	ι Aurigæ.
Level	W.18 E.24	W.18 E.24	W.18 E.24	W. 18 E. 24	W. 19 E. 23	W. 18 E. 25	W. 18 E. 25	W.20 E.23
Level reversed	W' 20 E' 21.5	W' 20.5 E' 21.5	W' 20.5 E' 21.5	W' 19 E' 23	W' 22 E' 20	W' 19 E' 24	W' 21 E' 21	W' 21 E' 22
Wire I	6 35 27.5	6 38 03.8	....	6 50 30.0	7 4 4.5	7 19 22.5	7 26 50.5	7 46 41.0
Wire II	35 49.8	38 25.5	6 40 05.3	50 54.0	4 25.0	....	27 11.5	47 5.5
Wire III	36 11.4	38 47.3	40 27.6	51 14.5	4 44.5	....	27 32.0	47 29.0
Wire IV	36 33.2	39 09.0	40 49.2	51 34.5	5 5.0	20 26.0	27 53.0	47 52.5
Wire V	36 54.0	39 30.5	41 10.8	51 55.0	5 24.5	20 46.5	28 13.5	48 16.5
Equal intervals	....	....	— 43.65	....	....	— 20.77		
Mean wire	6 36 11.18	6 36 47.22	6 40 27.31	6 51 14.20	7 4 44.70	7 20 4.74	7 27 32.10	—7 47 28.9
Rate, (+ 1.8 daily.)	+ 0.27	+ 0.27	+ 0.28	+ 0.29	+ 0.31	+ 0.32	+ 0.33	+ 0.36
Level	— 0.12	— 0.12	— 0.12	— ·0.16	— 0.03	— 0.20	— 0.12	— 0.07
Collimation	— 6.11	— 6.11	— 6.11	— 5.77	— 5.64	— 5.92	— 5.83	— 6.68
Az. deviation	+ 2.94	+ 2.94	+ 2.93	— 3.48	— 2.35	+ 2.04	+ 1.57	+ 4.91
*'s transit	6 36 8.16	6 38 44.20	6 40 24.29	6 51 5.08	7 4 36.99	7 20 0.98	7 27 28.05	7 47 27.42
*'s A. R.	3 36 27.84	3 39 3.87	3 40 44.43	3 51 25.35	4 4 57.27	4 20 20.87	4 27 47.78	4 47 46.53
Reduced to the catalogue	— 0.09	— 0.10	+ 0.37	+ 0.50	+ 0.51	+ 0.12	— 0.04	— 0.66
Error of chronometer	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23

Station—Santos.

Transit observations continued, January 23, 1858. Observer, Lieutenant N. Michler; Zenith Telescope by Wurdemann, No. 11; Sidereal Chronometer by Bond & Sons, No. 202; Computer, L. Daser.

	ε Leporis.	α Aurigæ.	β Tauri.	δ Orionis.	ε Orionis.	α Orionis.	η Orionis.	μ Geminorum.
Level	W. 18 E. 25.5	W. 20 E. 23	W. 20 E. 23.5	W. 18 E. 25	W. 18 E. 25	W. 20 E. 24	W. 20 E. 24	W. 21 E. 23.5
Level reversed	W' 19 E' 24.5	W' 19 E' 24	W' 22 E' 20.5	W' 22 E' 20.5	W' 15 E' 28	W' 23.5 E' 20.5	W' 20.5 E' 23.5	W' 23 E' 21.5
Wire I	7 58 36.0	8 4 57.0	8 16 17.5	8 23 53.0	8 28 9.0	8 46 35.5	8 58 33.0	9 13 24.5
Wire II	58 58.5	5 26.0	16 41.0	24 13.0	28 29.0	46 56.0	58 54.0	13 46.0
Wire III	59 19.5	5 54.0	17 3.5	24 33.0	28 48.5	47 16.0	59 14.5	14 6.5
Wire IV	59 41.5	6 23.5	17 26.0	24 53.0	29 8.0	47 36.5	59 35.5	14 29.0
Wire V	8 00 3.0	6 50.5	17 48.5	25 12.5	29 28.5	47 55.5	59 54.5	14 50.0
Eq. intervals								
Mean wire	7 59 19.70	8 5 54.20	8 17 3.30	8 24 33.00	8 28 48.60	8 47 15.90	8 59 14.30	9 14 7.20
Rate	+ 0.37	+ 0.38	+ 0.40	+ 0.41	+ 0.41	+ 0.43	+ 0.45	+ 0.47
Level	− 0.20	− 0.15	− 0.02	− 0.33	− 0.33	− 0.01	− 0.12	− 0.01
Collimation	− 6.06	− 8.04	− 6.37	− 5.60	− 5.60	− 5.64	− 5.79	− 6.06
Az. deviation	− 5.06	+ 8.48	+ 3.92	− 1.23	− 1.38	+ 0.04	+ 1.31	+ 2.74
*'s transit	7 59 8.75	8 5 54.87	8 17 01.23	8 24 26.25	8 28 41.70	8 47 10.72	8 59 10.15	9 14 4.34
*'s A. R.	4 59 28.43	5 6 14.13	5 17 20.70	5 24 46.66	5 29 2.00	5 47 30.66	5 59 29.53	6 14 23.98
Reduction to catalogue	− 0.09	− 0.51	− 0.30	+ 0.64	+ 0.53	+ 0.17	− 0.39	− 0.13
Error of chronometer	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23

Station—Saltos.

Transit observations continued, January 23, 1858. Observer, Lieutenant N. Michler; Zenith Telescope by Wurdemann, No. 11; Sidereal Chronometer by Bond & Sons, No. 202; Computer, L. Daser.

	α Argus.	α Can. Maj.	ε Can. Maj.	γ Can. Maj.	δ Geminorum.	α² Geminorum.	α Can. Min.	β Geminorum.
Level	W. 18 E. 25.5	W. 19 E. 26	W. 19 E. 26	W. 18.5 E. 26	W. 20.5 E. 24.5	W. 21 E. 24	W. 21 E. 24	W. 21 E. 24
Level reversed	W' 18.5 E' 26	W' 21.5 E' 22.5	W' 21.5 E' 22.5	W' 20 E' 24.5	W' 22.5 E' 22.5	W' 22.5 E' 22.5	W' 23 E' 23	W' 23 E' 23
Wire I	....	9 38 2.5	9 52 11.5	....	10 10 41.0	10 24 29.0	10 30 59.0	10 35 36.0
Wire II	....	38 23.5	52 35.0	9 56 50.5	11 2.5	24 52.5	31 19.5	35 59.5
Wire III	....	38 44.5	52 57.5	57 11.0	11 24.0	25 16.5	31 39.5	36 22.0
Wire IV	9 21 26.0	39 5.5	53 20.0	57 31.5	11 45.5	25 39.5	31 59.0	36 45.0
Wire V	....	39 26.0	53 42.0	57 52.5	12 6.5	26 03.0	32 19.5	....
Eq. intervals	− 33.02	....	....	....	....	....	....	+ 45.0
Mean wire	9 20 52.98	9 38 44.40	9 52 57.20	9 57 11.00	10 11 23.90	10 25 16.10	10 31 39.30	10 36 21.87
Rate	+ 0.48	+ 0.50	+ 0.52	+ 0.52	+ 0.54	+ 0.55	+ 0.56	+ 0.57
Level	− 0.20	− 0.12	− 0.12	− 0.19	− 0.07	− 0.05	− 0.05	− 0.05
Collimation	− 9.22	− 5.84	− 6.39	− 5.81	− 6.05	− 6.62	− 5.63	− 6.36
Az. deviation	− 13.42	− 3.94	− 6.30	− 3.66	+ 2.67	+ 4.74	− 0.25	+ 3.90
*'s transit	9 20 30.62	9 38 35.00	9 52 44.91	9 57 1.86	10 11 20.99	10 25 14.77	10 31 33.93	10 36 19.93
*'s A. R.	6 20 50.20	6 38 55.20	6 53 4.44	6 57 21.74	7 11 40.39	7 25 34.31	7 31 53.74	7 36 39.43
Reduction to catalogue	− 0.19	+ 0.43	− 0.24	+ 0.11	− 0.37	− 0.23	+ 0.04	− 0.27
Error of chronometer	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23	2 59 40.23

Station—Santos.

February 23.—Reduction of Transits by the method of least squares. Computer, L. Daser. Assumed error = — 2*h*. 59*m*. 40*s*.00.

	Δ	A	A²	A Δ	Az. Dev.
17 Tauri	+ 2.62	− 0.3118	+ 0.097	− 0.817	+ 2.94
η Tauri	+ 2.61	− 0.3118	0.097	0.814	+ 2.94
27 Tauri	+ 3.07	− 0.3107	0.097	0.955	+ 2.93
γ Eridani	− 3.21	+ 0.3690	0.136	1.184	− 3.48
δ Eridani	− 2.07	+ 0.2487	0.062	0.915	− 2.35
ε Tauri	+ 1.93	− 0.2159	0.047	0.417	+ 2.04
α Tauri	+ 1.30	− 0.1655	0.028	0.215	+ 1.57
ι Aurigæ	+ 4.02	− 0.5198	0.270	2.090	+ 4.91
ε Leporis	− 5.38	+ 0.5356	0.287	2.884	− 5.06
α Aurigæ	+ 7.74	− 0.8992	0.808	6.958	+ 8.48
β Tauri	+ 3.39	− 0.4153	0.172	1.407	+ 3.92
δ Orionis	− 0.82	+ 0.1302	0.017	0.107	− 1.23
ε Orionis	− 1.08	+ 0.1456	0.021	0.158	− 1.38
α Orionis	− 0.02	− 0.0045	0.000	0.000	+ 0.04
ν Orionis	+ 0.69	− 0.1387	0.019	0.096	+ 1.31
μ Geminorum	+ 2.38	− 0.2896	0.084	0.690	+ 2.74
α Argus	−13.84	+ 1.4221	2.022	19.680	−13.42
α Can. Maj	− 3.74	+ 0.4180	0.175	1.563	− 3.94
ε Can. Maj	− 6.77	+ 0.6683	0.446	4.522	− 6.30
γ Can. Maj	− 3.78	+ 0.3880	0.151	2.525	− 3.66
δ Geminorum	+ 2.07	− 0.2826	0.080	0.586	+ 2.67
α² Geminorum	+ 4.33	− 0.5017	0.252	2.174	+ 4.74
α Can. Min	− 0.44	+ 0.0261	0.001	0.011	− 0.25
β Geminorum	+ 3.40	− 0.4126	0.171	1.404	+ 3.90
	+39.55	+ 4.3516	+ 5.540	− 52.172	
	−41.15	− 4.7797			
	− 1.60	− 0.4281			

$$\left.\begin{aligned} 24\epsilon - 0.428\,a &= -\ 1.16 \\ -0.428\epsilon + 5.54\,a &= -\ 52.172 \end{aligned}\right\} \epsilon = \frac{0.428\,a - 1.6}{24} = \frac{52.172 + 5.54\,a}{0.428}$$

$$0.0229\,a - 0.0856 = 156.516 + 16.62\,a$$
$$-\ 156.606 = +\ 16.5971\,a$$
$$a = -\ 9.435$$
$$\epsilon = -\ 0.235$$

E = — 2*h*. 59*m*. 40*s*.23.

Station—Saltos.

Transit observations, January 24, 1858. Observer, Lieutenant N. Michler; Zenith Telescope, by Wurdemann, No. 11; Sidereal Chronometer, by Bond & Sons, No. 202; Computer, L. Daser.

	17 Tauri.	η Tauri.	27 Tauri.	τ Tauri.	ι Aurigæ.	δ Orionis.	α Orionis.
Level	W. 22.5 E. 20	W. 22.5 E. 20	W. 22.5 E. 20	W. 21 E. 22	W. 25 E. 18	W. 21 E. 23.5	W. 23 E. 22
Level reversed	W′ 26 E′ 16.5	W′ 26 E′ 16 5	W′ 26 E′ 16.5	W′ 23 E′ 20	W′ 24 E′ 15	W′ 24 E′ 21.5	W′ 23.5 E′ 21
Wire I	6 35 29.0	6 38 4.5	6 39 45.2	7 32 46.0	7 41 43.8	8 3 51.0	....
Wire II	35 50.5	38 27.5	40 7.0	33 8.5	42 8.0	24 11.0	....
Wire III	36 12.8	38 48.5	40 28.8	33 29.5	42 31.0	24 30.5	8 47 14.5
Wire IV	36 34.0	39 10.5	50 50.7	33 51.5	42 55.0	24 50.5	47 35.5
Wire V	36 55.5	39 31.0	41 11.9	34 12.2	43 18.2	25 9.5	47 54.0
Eq. intervals	....	....	....	....	....	....	— 60.23
Mean wire	6 36 12.36	6 38 48.40	6 40 28.72	7 33 29.54	7 42 31.20	8 24 30.50	8 47 14.59
Rate	+ 0.27	+ 0.27	+ 0.28	+ 0.34	+ 0.36	+ 0.41	+ 0.43
Level	+ 0.21	+ 0.21	+ 0.21	+ 0.03	+ 0.29	+ 0.00	+ 0.06
Collimation	— 6.11	— 6.11	— 6.11	— 6.06	— 6.68	— 5.60	— 5.64
Az. deviation	— 0.20	— 0.20	— 0.20	— 0.19	— 0.34	+ 0.08	0.00
*'s transit	6 36 6.35	6 38 42.57	6 40 22.90	7 33 23.66	7 47 24.83	8 24 25.39	8 47 9.44
*'s A. R	3 36 27.84	3 39 3.86	3 40 44.41	4 33 44.84	4 47 46.52	5 24 46.65	5 47 30.66
Reduction to the catalogue	+ 0.15	— 0.05	+ 0.17	— 0.16	+ 0.35	— 0.08	— 0.12
Error of chronometer	2 59 38.66	2 59 38.66	2 59 38.66	2 59 38.66	2 59 38.66	2 59 38.66	2 59 38.66

Transit observations continued, January 24, 1858. Observer, Lieutenant N. Michler; Zenith Telescope, by Wurdemann, No. 11; Sidereal Chronometer, by Bond & Son, No. 202; Computer, L. Daser.

	μ Geminorum.	α Can. Maj.	ε Can. Maj.	δ Geminorum.	α Can. Min.	β Geminorum.
Level	W. 19 E. 26	W. 20 E. 26	W. 21 E. 24.5	W. 23.5 E. 21.5	W. 23 E. 23	W. 23 E. 23
Level reversed	W' 21.5 E' 24.5	W' 22 E' 24	W' 21.5 E' 24	W' 24 E' 21	W' 24.5 E. 21.5	W' 24.5 E' 21.5
Wire I	9 13 25.0	9 37 58.0		10 10 41.5	10 30 57.5	10 35 39.0
Wire II	13 47.5	38 19.0		11 3.25	31 17.5	36 1.8
Wire III	14 8.5	38 39.5	9 52 48.0	11 25.0	31 37.75	36 24.5
Wire IV	14 30.0	39 0.5	53 12.0	11 46.0	31 37.5	36 47.0
Wire V	14 50.5	39 20.5	53 33.0	12 7.5	32 17.5	37 9.2
Equal intervals			— 68.15			
Mean wire	9 14 8.30	9 38 39.50	9 52 48.28	10 11 24.61	10 31 37.55	10 36 24.30
Rate	+ 0.47	+ 0.50	+ 0.52	+ 0.54	+ 0.57	+ 0.57
Level	— 0.17	— 0.13	— 0.09	+ 0.09	+ 0.05	+ 0.05
Collimation	— 6.06	— 5.84	— 6.39	— 6.05	— 5.63	— 6.36
Az. deviation	— 0.19	+ 0.27	+ 0.43	— 0.18	+ 0.02	— 0.27
*'s transit	9 14 2.35	9 38 34.30	9 52 42.75	10 11 19.01	10 31 32.56	10 36 18.29
*'s A. R.	6 14 23.98	6 38 55.20	6 53 4.44	7 11 40.40	7 31 53.74	7 36 39.43
Reduction to the catalogue	+ 0.29	— 0.44	+ 0.35	+ 0.05	— 0.16	— 0.20
Error of chronometer	2 59 38.66	2 59 38.66	2 59 38.66	2 59 38.66	2 59 38 66	2 59 38.66

Station—Saltos.

January 24, 1858. Reduction of Transits by the method of least squares. Assumed error = — 2h. 59m. 38.60s. Computer, L. Daser.

Star's name.	Δ	A	A²	A Δ	Az. Dev.
17 Tauri	—0.47	—0.312	+0.097	+0.147	—0.20
η Tauri	0.49	0.312	0.097	0.153	0.20
27 Tauri	0.27	0.311	0.097	0.084	0.20
τ Tauri	0.37	0.291	0.085	0.108	0.19
ι Aurigæ	0.02	0.520	0.270	0.010	0.34
δ Orionis	0.01	+0.130	0.017	—0.001	+0.08
α Orionis	0.14	—0.004	0.000	+0.001	0.00
μ Geminorum	+0.10	—0.290	0.084	—0.029	—0.19
α Can. Maj	—0.18	+0.418	0.175	—0.075	+0.27
ε Can. Maj	+0.78	+0.668	0.446	+0.521	+0.43
δ Geminorum	—0.12	—0.283	0.080	+0.034	—0.18
α Canis Minoris	0.13	+0.026	0.001	—0.003	+0.02
μ Geminorum	0.47	—0.413	0.171	+0.194	—0.27
	+0.88	+1.242	+1.620	+1.252	
	—2.67	—2.736		—0.108	
	—1.79	—1.494		+1.144	

$$\left.\begin{aligned} 13\,\epsilon - 1.494\,a &= -1.79 \\ -1.494\,\epsilon + 1.62\,a &= +1.144 \end{aligned}\right\}\ \epsilon = \frac{1.494\,a - 1.79}{13} = \frac{1.62\,a - 1.144}{1.494}$$

$$+1.116\,a - 1.337 = 10.53\,a - 7.436$$

$$+6.099 = +9.414\,a$$

$$a = +0.648$$

$$\epsilon = -0.063$$

$$E = -2h.\ 59m.\ 38.66s.$$

Transit observations, January 25, 1858. Observer, Lieutenant N. Michler; Zenith Telescope, by Wurdemann, No. 11; Sidereal Chronometer, by Bond & Son, No. 202; Computer, L. Daser.

	α Persei.	μ Tauri.	γ Eridani.	o' Eridani.	ε Tauri.	α Tauri.	☾[1]	τ Tauri.
Level	W.19 E.20.5	W.19 E.21	W.18.5 E.22	W.18 E.23	W.21 E.21	W.18.5 E.22.5	W.23 E.19	W.20 E.21
Level reversed	W' 19 E' 20.5	W' 21 E' 19	W' 18.5 E' 22	W' 22.5 E' 18.5	W' 20 E' 21	W' 23 E' 18	W' 22 E' 20	W' 18 E' 23
Wire I.	6 12 56.0	6 38 2.5	6 50 26.5	7 3 59.0	7 19 20.5	7 26 48.0	8 17 0.0	7 32 44.0
Wire II.	13 26.5	38 24.5	50 47.2	4 19.0	19 41.8	27 9.0	....	33 5.5
Wire III.	13 57.5	38 46.0	51 8.0	4 39.0	20 3.2	27 29.5	17 46.8	33 27.0
Wire IV.	14 28.0	39 7.5	51 28.5	4 59.0	20 24.0	27 50.5	18 10.3	33 48.5
Wire V.	14 58.0	39 29.0	51 48.4	5 19.0	20 44.0	28 11.0	....	34 9.0
Equal intervals	....	....	....	....	....	....	+ 22.05	....
Mean wire	6 13 57.20	6 38 45.90	6 51 7.72	7 4 39.00	7 20 2.70	7 27 29.60	8 17 46.38	7 33 26.80
Rate	+ 0.24	+ 0.27	+ 0.29	+ 0.31	+ 0.32	+ 0.33	+ 0.40	+ 0.34
Level	− 0.06	0.00	− 0.11	− 0.02	0.00	+ 0.02	+ 0.11	− 0.10
Collimation	− 8.60	− 6.11	− 5.77	− 5.64	− 5.92	− 5.83	− 6.36	− 6.06
Az. deviation	+ 0.74	+ 0.22	− 0.27	− 0.18	− 0.16	+ 0.11	+ 0.29	+ 0.21
*'s transit	6 13 49.52	6 38 40.28	6 51 1.86	7 4 33.47	7 19 57.26	7 27 24.23	8 17 40.82	7 33 21.19
*'s A. R.	3 14 12.93	3 39 3.85	3 51 25.32	4 4 57.25	4 20 20.85	4 27 47.76	....	4 33 44.83
Reduction to the catalogue	− 0.26	− 0.10	− 0.21	+ 0.11	− 0.08	− 0.14	....	− 0.03
Error of chronometer	2 59 36.33	2 59 36.33	2 59 36.33	2 59 36.33	2 59 36.33	2 59 36.33	....	2 59 36.33

Station—Saltos.

Transit observations, January 25, 1858. Observer, Lieutenant N. Michler; Zenith Telescope, by Wurdemann, No. 11; Sidereal Chronometer, by Bond & Son, No. 202; Computer, L. Daser.

	ι Aurigæ.	136 Tauri.	γ Orionis.	μ Geminorum.	ε Can. Maj.
Level	W. 18.5 E. 23.5	W. 21 E. 21	W. 22.5 E. 20.5	W. 20 E. 24	W. 19 E. 25
Level reversed	W′ 23.5 E′ 18.5	W′ 25 E′ 18	W′ 22 E′ 21	W′ 18 E′ 25	W′ 20 E′ 24
Wire I	7 46 41.5	8 43 22.5	8 58 29.5	9 13 23.0	9 52 1.8
Wire II	47 5.5	43 45.6	58 50.8	13 44.5	52 25.0
Wire III	47 28.8		59 11.0	14 6.0	52 47.5
Wire IV	47 52.8	44 30.5	59 31.5	14 27.5	53 10.5
Wire V	48 16.2	44 52.5	59 51.5	14 48.5	53 32.8
Eq. intervals		+ 0.08			
Mean wire	7 47 28.96	8 44 7.79	8 59 10.86	9 14 5.90	9 52 47.52
Rate	+ 0.36	+ 0.43	+ 0.45	+ 0.47	+ 0.52
Level	0.00	+ 0.12	+ 0.05	— 0.19	— 0.15
Collimation	— 6.68	— 6.32	— 5.79	— 6.06	— 6.39
Az. deviation	+ 0.37	+ 0.28	+ 0.10	+ 0.21	— 0.48
*'s transit	7 47 23.01	8 44 2.30	8 59 5.67	9 14 0.33	9 52 41.02
*'s A. R	4 47 46.51	5 44 25.98	5 59 29.53	6 14 23.98	6 53 4.43
Reduction to the catalogue	— 0.17	+ 0.01	+ 0.19	— 0.02	— 0.26
Error of chronometer	2 59 36.33	2 59 36.33	2 59 36.33	2 59 36.33	2 59 36.33

January 25, 1858. Reduction of Transits by the method of least squares. Assumed error = — 2*h*. 59*m*. 36.30*s*. Computer, L. Daser.

Star's name.	Δ	A	A²	A Δ	Az. dev.
α Persei	+0.48	—1.033	+1.067	—0.496	+0.74
η Tauri	+0.13	—0.312	0.097	0.041	+0.22
γ Eridani	—0.46	+0.369	0.136	0.170	—0.27
o¹ Eridani	—0.06	+0.249	0.062	0.015	—0.18
ε Tauri	+0.10	—0.216	0.047	0.022	+0.16
α Tauri	0.00	0.166	0.028	0.000	0.11
τ Tauri	0.21	0.291	0.085	0.061	0.21
ι Aurigæ	0.23	0.520	0.270	0.120	0.37
136 Tauri	0.57	0.395	0.156	0.225	0.28
γ Orionis	0.34	0.139	0.019	0.047	0.10
μ Geminorum	0.24	0.290	0.084	0.070	0.21
ε Can. Maj.	—0.68	+0.668	0.446	0.454	—0.48
	+1.10	—2.075	+2.497	—1.721	

$$\left.\begin{aligned} 12\epsilon - 2.075\,a &= 1.10 \\ -2.075\,\epsilon + 2.497\,a &= -1.721 \end{aligned}\right\} \quad \epsilon = \frac{1.1 + 2.075\,a}{12} = \frac{1.721 + 2.497\,a}{2.075}$$

$$2.2825 + 4.306\,a = 20.652 + 29.964\,a$$

$$-18.3695 = +25.658\,a$$

$$a = -0.716$$

$$\epsilon = -0.032$$

$$E = -2h.\ 39m.\ 36.33s.$$

Station—Saltos.

January 25.—Moon Culmination. Observer, L. N. Michler; Computer, L. Daser.

I. Wire.......	8 17 00.0		
II. Wire.......		19.72	
III. Wire.......	17 46.8		
IV. Wire.......	18 10.3		
V. Wire.......		+ 39.61	
	log.	+ 19.89	= 1.29863
	sec. D		= 0.05521
		s. 22.59	= 1.35384
		− 0.54	
		+ 22.05	
Eq. intervals..................	=	+ 22.05	

Mean wire,	8 17 46.38
Rate,	+ 0.40
Level,	+ 0.11
Collimation,	− 6.36
Az. Dev.,	+ 0.29
	8 17 40.82
	2 59 36.38
☾'s A. R.	5 18 04.44 at Saltos.
	5 18 00.09 at Wash'n Observatory.
	4.35

Log. 4.35 = 9.63849
Log. 3600 = 3.55630

3.19479

☾ var. = 2.23870

0.95609 = 90.39s.

	° ′ ″		
Horizontal Parallax,	= 1 00 04.0	Sin.	= 8.24234
Latitude,	= 7 04 35	Cos.	= 9.99668
Interval in arc,	= 5 38.85	Sin.	= 7.21558
Declination,	= 28 16 57	Sec.	= 0.05521
Parallax in A.R., (in arc)	= ″ 6.68	Sin.	= 5.50981
in time	= + 0.445		

Moon's var. in long..(log.) = (2.23870)
Interval ....(log.) = (1.35384)

3.59254

3600 s...(log.) = 3.55630

☾'s motion in A. R. = − 1.082 = 0.03624

Par. in A. R. = + 0.445
− 0.537

Chron. error of moon culminating stars:

	° ′ ″
η Tauri..	2 59 36.43
ε Tauri..	36.41
τ Tauri..	36.36
136 Tauri..	36.32
	2 59 36.38

Station—Saltos.

Transit Observations, January 26, 1858. Observer, Lieutenant N. Michler; Zenith Telescope by Wurdemann, No. 11; Sidereal Chronometer by Bond & Sons, No. 202; Computer, L. Daser.

	η Tauri.	27 Tauri.	ε Tauri.	α Tauri.	ε Leporis.
Level	W. 18 E. 25	W. 18 E. 25	W. 25.5 E. 19.5	W. 23 E. 21	W. 24 E. 21
Level reversed	W' 21 E' 22	W' 21 E' 22	W' 26 E' 17	W' 24.5 E' 19.5	W' 26 E' 19
Wire I	....	6 39 41.5	7 19 17.0	7 26 45.0	....
Wire II	6 38 22.8	40 3.0	19 38.5	27 5.8	7 58 49.0
Wire III	38 44.0	40 24.5	19 59.5	27 26.5	59 10.2
Wire IV	....	40 46.5	....	....	59 32.0
Wire V	39 26.5	....	....	....	59 53.2
Eq. Intervals	− 21.79	+ 43.23	+ 63.05	+ 62.13	− 43.33
Mean wire	6 38 43.84	6 40 24.63	7 19 59.35	7 27 26.48	7 59 10.27
Rate	+ 0.27	+ 0.28	+ 0.32	+ 0.33	+ 0.37
Level	− 0.14	− 0.14	+ 0.26	+ 0.12	+ 0.16
Collimation	− 6.11	− 6.11	− 5.92	− 5.83	− 6.06
Az. deviation	+ 0.90	+ 0.90	− 0.63	+ 0.48	− 1.55
*'s transit	6 38 38.76	6 40 19.56	7 19 54.64	7 27 21.58	7 59 3.22
*'s A. R.	3 39 3.83	3 40 44.38	4 20 20.84	4 27 47.75	4 59 28.39
Reduction to catalogue	− 0.41	− 0.66	+ 0.72	+ 0.69	− 0.31
Error of chronometer	2 59 34.52	2 59 34.52	2 59 34.52	2 59 34.52	2 59 34.52

Station—Saltos.

Transit observations continued, January 26, 1858. Observer, Lieutenant N. Michler; Zenith Telescope, by Wurdeman, No. 11; Sidereal Chronometer, by Bond & Son, No. 202. Computer, L. Daser.

	β Tauri.	ε Orionis.	136 Tauri.	139 Tauri.	☾ 1
Level	W. 28.5 E. 17.5	W. 23.5 E. 22	W. 27 E. 19	W. 27 E. 19	W. 27 E. 19
Level reversed	W′ 27.5 E′ 18.5	W′ 27.5 E′ 19	W′ 28 E′ 18	W′ 28 E′ 18	W′ 28 E′ 18
Wire I	....	....	....	....	9 26 37.0
Wire II	....	8 28 22.0	....	8 38 30.0	....
Wire III	....	28 42.0	....	38 52.5	27 24.0
Wire IV	8 17 23.0	29 2.0	8 44 27.0	....	27 47.5
Wire V	17 45.0	29 21.5	44 49.0	....	28 10.0
Eq. intervals	− 67.88	− 40.02	− 67.30	+ 21.85	− 23.02
Mean wire	8 17 0.06	8 28 41.87	8 44 4.35	8 38 52.18	9 27 23.87
Rate	+ 0.40	+ 0.41	+ 0.43	+ 0.44	+ 0.49
Level	+ 0.35	+ 0.15	+ 0.32	+ 0.35	+ 0.35
Collimation	− 6.37	− 5.60	− 6.32	− 6.25	− 6.35
Az. deviation	+ 1.20	− 0.42	+ 1.15	+ 1.01	+ 1.18
*'s transit	8 16 55.64	8 28 36.41	8 43 59.93	8 49 47.75	9 27 19.51
*'s A. R.	5 17 20.67	5 29 1.98	5 44 25.97	5 49 12.89	
Reduction to the catalogue	− 0.45	+ 0.19	+ 0.56	− 0.34	
Error of chronometer	2 59 34 52	2 59 34.52	2 59 34.52	2 59 34.52	

Station—*Saltos.*

January 26, 1858.—Reduction of Transits by the method of least squares. Computer, L. Daser. Assumed Error, — 2*h.* 59*m.* 34*s*.40.

Star's name.	Δ	A	A^2	A Δ	Az. Dev.
η Tauri	+0.37	−0.312	+0.097	−0.115	+0.90
27 Tauri	0.12	0.311	0.097	0.137	0.90
ϵ Tauri	1.27	0.216	0.047	0.274	0.63
α Tauri	1.05	0.166	0.028	0.174	0.48
ϵ Leporis	−1.95	+0.536	0.287	1.045	−1.55
β Tauri	+0.63	−0.415	0.172	0.261	+1.20
ϵ Orionis	−0.45	+0.146	0.021	0.066	−0.42
136 Tauri	+1.59	−0.395	0.156	0.628	+1.15
139 Tauri	+0.55	−0.348	0.121	0.191	+1.01
	+5.58	+0.682	+1.026	−2.791	
	−2.40	−2.163			
	+3.18	−1.481			

$$\left.\begin{aligned} 9\,\epsilon - 1.481\,a &= +3.18 \\ -1.481\,\epsilon + 1.026\,a &= -2.791 \end{aligned}\right\}\ \epsilon = \frac{3.18 + 1.481\,a}{9} = \frac{2.791 + 1.026\,a}{1.481}$$

$$4.710 + 2.193\,a = 25.119 + 9.234\,a$$

$$-20.409 = +7.041\,a$$

$$a = -2.898$$

$$\epsilon = -0.124$$

E = — 2*h.* 59*m.* 34*s*.52.

Station—Saltos.

January 26, 1858. Moon culmination. Observer, Lieutenant N. Michler; Computer, L. Daser.

I wire	9 26 39.0	
II wire		19.72
III wire	27 24.0	
IV wire	27 47.5	
V wire	28 10.0	1.29491
	— 23.02	0.05486
		1.34977
		22.375s.
		5′ 35.62″
		+ 0.64
		23.02
Transit	9 27 23.87	
	2 59 34.52	
	6 27 49.35	
Rate	+ 0.49	
Level	+ 0.32	
Collimation	— 6.35	
Az. dev	+ 1.18	
A. R.	6 27 44.99 at Saltos.	
A. R.	6 27 40.62 at Washington Obs.	
	4.37	

	° ′ ″		
Horizontal parallax	1 0 12.3	Sin.	8.24334
Latitude	7 4 35.0	Cos.	9.99668
Interval	5 35.62	Sin.	7.21142
Declination	28 11 43.0	Sin.	0.05486
	6.64 =		5.50630
Parallax in A. R.			= — 0.44
☾'s variation in A. R., (own motion)			= 2.23950
Interval			= 1.34977
			3.58927
3600″			= 3.55630
	+ 1.08		0.03297
Correction for interval			= + 0.64

Log. 4.37 = 0.64048
Log. 3600 = 3.55630

4.19678

☾ Motion in A. R. = 2.23950

1.95728 = 90.63s.

Station—Saltos.

Transit observations, January 27, 1858. Observer, Lieutenant N. Michler; Zenith Telescope, by Wurdemann, No. 11: Sidereal Chronometer, by Bond & Son, No. 202: Computer, L. Daser.

	α Persei.	η Tauri.	27 Tauri.	γ Eridani.	α Orionis.	γ Orionis.
Level	W. 17 E. 28	W. 22.5 E. 24	W. 22.5 E. 24	W. 21 E. 25	W. 22.5 E. 24.5	W. 22 E. 25
Level reversed	W' 21 E' 24	W' 24.5 E' 22	W' 24.5 E' 22	W' 22.5 E' 23.5	W' 24 E' 23	W' 24 E' 23
Wire I		6 37 57.5	6 39 38.5		8 46 28.0	
Wire II	6 13 22.0	38 20.5	40 0.5	6 50 45.0	46 48.5	
Wire III	13 52.0	38 42.0	40 22.0	51 05.5	47 9.0	
Wire IV	14 23.0	39 4.0	40 44.5	51 26.0	47 29.2	8 59 28.5
Wire V	14 53.5	39 25.0	41 5.5	51 46.0		
Eq. intervals	— 61.43			— 41.22	+ 39.94	— 20.73
Mean wire	6 13 52.22	6 38 41.80	6 40 22.20	6 51 05.32	8 47 8.66	8 59 7.77
Rate	+ 0.24	+ 0.27	+ 0.28	+ 0.29	+ 0.43	+ 0.45
Level	— 0.26	+ 0.02	+ 0.02	— 0.08	— 0.02	— 0.03
Collimation	— 8.60	— 6.11	— 6.11	— 5.77	— 5.64	— 5.79
Az. deviation	+ 3.56	+ 1.08	+ 1.07	— 1.27	+ 0.01	+ 0.48
*'s transit	6 13 47.16	6 38 37.06	6 40 17.46	6 50 58.49	8 47 3.44	8 59 2.88
*'s A. R.	3 14 12.89	3 39 3.82	3 40 44.37	3 51 23.30	5 47 30.64	5 59 29.52
Reduction to the catalogue	— 0.92	+ 0.11	+ 0.26	+ 0.16	+ 0.55	— 0.01
Error of chronometer	2 59 33.35	2 59 33.35	2 59 33.35	2 59 33.35	2 59 33.35	2 59 33.35

Station—Saltos.

Transit observations, January 27, 1858—Continued. Observer, Lieutenant N. Michler; Zenith Telescope, by Wurdemann, No. 11; Sidereal Chronometer, by Bond & Son, No. 202; Computer, L. Daser.

	μ Geminorum.	α Argus.	γ Geminorum.	α Can. Maj.	☾ 1
Level	W. 22 E. 25	W. 14 E. 23	W. 22 E. 25	W. 18 E. 29	W. 22.5 E. 25.5
Level reversed	W′ 23 E′ 24	W′ 21 E′ 26	W′ 22 E′ 25	W′ 23 E′ 25	W′ 24.5 E′ 23
Wire I	....	9 19 32.0	9 28 28.0	9 37 53.0	....
Wire II	....	20 6.0	28 50.0	38 14.0	10 35 7.5
Wire III	9 14 2.0	20 38.0	29 10.5	38 35.5	35 30.0
Wire IV	14 23.5	21 11.5	29 31.5	38 56.0	35 53.0
Wire V	14 45.0	21 43.5	29 52.0	39 16.5	36 15.5
Eq. intervals	— 64.69	....	....	....	— 45.69
Mean wire	9 14 1.94	9 20 38.20	9 29 5.54	9 38 28.01	10 35 25.63
Rate	+ 0.47	+ 0.48	+ 0.49	+ 0.50	+ 0.57
Level	— 0.07	— 0.33	— 0.10	— 0.21	— 0.3
Collimation	— 6.06	— 9.22	— 5.84	— 5.84	— 6.23
Az. deviation	+ 1.00	— 4.90	+ 0.59	— 1.44	+ 1.24
*'s transit	9 13 57.28	9 20 24.23	9 29 5.54	9 38 28.01	10 35 25.63
*'s A. R	6 14 23.97	6 20 50.13	6 29 32.28	6 38 55.19	
Reduced to the catalogue	+ 0.04	— 0.75	+ 0.09	+ 0.52	
Error of chronometer	2 59 33.35	2 59 33.35	2 59 33.35	2 59 33 35	

Reduction of transit by method of least squares. Assumed error = — 2*h*. 59*m*. 33*s*.30.

*'s name.	Δ	A	A²	AΔ	Az. Dev.
α Persei	+ 2.59	— 1.033	+ 1.67	— 2.675	+ 3.56
η Tauri	+ 1.14	— 0.312	0.97	0.356	+ 1.8
27 Tauri	+ 1.28	— 0.311	0.97	0.398	+ 1.7
γ Eridani	— 1.24	+ 0.369	0.136	0.458	— 1.27
α Orionis	+ 0.51	— 0.004	0.0	0.0	+ 0.1
γ Orionis	+ 0.42	— 0.139	0.19	0.58	+ 0.48
μ Geminorum	+ 0.99	— 0.290	0.84	0.287	+ 1.0
α Argus	— 5.77	+ 1.422	2.22	8.105	— 4.90
γ Geminorum	+ 0.63	— 0.171	0.29	0.108	+ 0.59
α Can. Maj	— 0.96	+ 0.418	0.175	0.401	— 1.44
	+ 7.56	+ 2.209	+ 3.726	— 12.848	
	— 7.90	— 2.260			
	— 0.34	— 0.51			

$$\left.\begin{array}{r} 10\,\epsilon - 0.051\,a = -\ \ 0.34 \\ -0.51\,\epsilon + 3.726\,a = -12.848 \end{array}\right\} \epsilon = \frac{0.051\,a - 0.34}{10} = \frac{12.848 + 3.726\,a}{0.051}$$

$$0.0026\,a - 0.0173 = 128.48 + 37.26\,a$$

$$a = -3.449$$

$$\epsilon = -0.05$$

$$E = -2h.\ 59m.\ 33s.35.$$

Station—Saltos.

January 27, 1858.—Moon Culmination. Observer, Lieutenant N. Michler; Computer, L. Daser.

I. Wire		40.1	
III. Wire	10 35 7.5		
III. Wire	35 30.0		
V. Wire	35 53.0		
V. Wire	36 15.5		
	22 46.0	— 1.60217	
	— 45.69	0.04615	
	22 0.31	1.64832	
		— 44.50	
		1.19	
		45.69	
	10 35 30.8		
Rate	+ 0.57		
Level	— 0.03		
Collimation	— 6.23		
Az. Dev	+ 1.24		
☾'s transit	10 35 25.63		
	2 59 33.16		
☾'s A. R	7 35 52.47		at Saltos.
☾'s A. R	7 35 48.40		at Washington.
	4.03		

Horizontal parallax	= 1 0 7.8	Sin.	= 8.24272
Latitude	7 4 35.0	Cos.	9.99668
Interval	11 7.5	Sin.	7.51002
Declination	25 56 59.0	Sec.	0.04616
	12″.89		= 5.79558
	= — 0.86 *s.*		
☾'s motion in A. R			= 2.21895
Interval			1.64832
			3.86727
3600 *s*			3.55630
	+ 2.046		= 0.31097
Correction			= + 1.19 *s.*
η Tauri	— 2 59 33.24		
27 Tauri	33.09		
	2 59 33.16		
	4.03		= 0.60531
	3600		= 3.55630
			4.16161
☾'s var. in A. R			2.21895
			1.94266
			= 87*s*.63.

Transit observations, January 28, 1858. Observer, Lieutenant N. Michler; Zenith Telescope, by Wurdemann, No. 11; Sidereal Chronometer, by Bond & Son, No. 202; Computer, L. Daser.

	α Persei.	η Tauri.	27 Tauri.	ε Tauri.	α Tauri.	ε Leporis.
Level	W. 26 E. 28	W. 24 E. 21	W. 24 E. 21	W. 26 E. 20	W. 23 E. 22	W. 26 E. 20
Level reversed	W' 21 E' 23	W' 25 E' 20	W' 25 E' 20	W' 27 E' 19	W' 25 E' 20	W' 29 E' 17
Wire I	6 12 47.5	6 38 55.0		7 19 13.5	7 26 41.5	7 58 23.5
Wire II	13 19.0			19 35.5	27 2.5	58 45.0
Wire III	13 50.0		6 40 20.0	19 56.5	27 23.5	59 6.5
Wire IV	14 20.5		40 42.0	20 17.5	27 44.0	59 28.5
Wire V	14 50.5			20 38.0	28 5.5	59 50.0
Eq. intervals		+ 43.68	− 21.96			
Mean wire	6 13 49.50	6 39 38.68	6 40 20.02	7 19 56.20	7 27 23.30	7 59 6.70
Rate	+ 0.24	+ 0.27	+ 0.28	+ 0.32	+ 0.33	+ 0.37
Level	− 0.26	+ 0.14	+ 0.14	+ 0.24	+ 0.10	+ 0.28
Collimation	− 8.60	− 6.11	− 6.11	− 5.92	− 5.83	− 6.06
Az. deviation	+ 3.58	+ 1.08	+ 1.08	+ 0.75	+ 0.58	− 1.86
*'s transit	6 13 44.46	6 39 34.06	6 40 15.41	7 19 51.59	7 27 18.48	7 58 59.43
*'s A. R.	3 14 12.87	3 39 3.81	3 40 44.35	4 20 20.82	4 27 47.73	4 59 28.37
Reduction to the catalogue	− 0.77	+ 0.57	+ 0.24	+ 0.03	+ 0.05	− 0.24
Error of chronometer	2 59 30.82	2 59 30.82	2 59 30.82	2 59 30.82	2 59 30.82	2 59 30.82

Station Saltos.

Transit observations continued, January 28, 1858. Observer, Lieutenant N. Michler; Zenith Telescope, by Wurdemann, No. 11; Sidereal Chronometer, by Bond & Son, No. 202; Computer, L. Daser.

	δ Orionis.	α Columbæ.	α Orionis.	γ Orionis.	μ Geminorum.	α ²Geminorum.
Level	W. 27 E. 20	W. 23.5 E. 20	W. 25 E. 22.5	W. 26 E. 21	W. 25 E. 22	W. 23 E. 24
Level reversed	W′ 26.5 E′ 20.5	W′ 25 E′ 23.5	W′ 26 E′ 21	W′ 24.5 E′ 22.5	W′ 27 E′ 20	W′ 25 E′ 24
Wire I	8 23 42.5	8 33 24.0	8 46 26.0	....	8 13 15.5	10 24 21.5
Wire II	24 3.0	33 48.5	46 46.0	....	13 38.0	24 46.0
Wire III	24 22.5	34 12.5	47 06.5	....	13 59.5	25 09.0
Wire IV	24 42.5	34 36.5	47 26.5	8 59 25.5	14 21.0	....
Wire V	25 2.5	35 0.5	47 46.5	59 46.0	14 42.0	....
Eq. intervals	....	....	....	− 61.70	....	+ 61.50
Mean wire	8 24 22.60	8 34 12.40	8 47 6.30	8 59 4.90	4 31 59.20	10 25 9.00
Rate	+ 0.41	+ 0.42	+ 0.43	+ 0.45	+ 0.47	+ 0.56
Level	+ 0.21	+ 0.03	+ 0.13	+ 0.12	+ 0.17	0.00
Collimation	− 5.60	− 6.76	− 5.64	− 5.79	− 6.06	− 6.62
Az. deviation	− 0.45	− 2.76	+ 0.01	+ 0.48	+ 1.01	+ 1.74
*'s transit	8 24 17.17	8 34 3.33	8 47 1.23	8 59 0.16	8 13 54.79	10 25 4.68
*'s A. R.	5 24 46.63	5 34 32.11	5 47 30.64	5 59 29.52	6 14 23.97	7 25 34.32
Reduction to the catalogue	+ 0.28	− 0.40	+ 0.23	+ 0.18	0.00	+ 0.46
Error of chronometer	2 59 30.82	2 59 30.82	2 59 30.82	2 59 30.82	2 59 30.82	2 59 30.82

Station Satios.

Transit observations continued, January 28, 1858. Observer, Lieutenant N. Michler; Zenith Telescope, by Wurdemann, No. 11; Sidereal Chronometer, by Bond & Son, No. 202. Computer, L. Daser.

	α Can. Min.	β Geminorum.	δ Geminorum.	C. Cancri.	☾ 1	γ Cancri.
Level	W. 24 E. 24	W. 24 E. 24	W. 24 E. 24	W. 24 E. 24	W. 27 E. 22	W. 27 E. 22
Level reversed	W' 25 E' 23	W' 25 E' 23	W' 25 E' 23	W' 26 E' 22	W' 28 E' 21	W' 28 E' 21
Wire I	10 30 50.0	10 35 29.5	....	....	....	....
Wire II	31 10.0	....	10 44 3.5	....	11 38 57.0	....
Wire III	31 30.0	....	....	....	39 18.5	....
Wire IV	31 50.0	....	44 47.5	10 54 47.5	39 40.0	....
Wire V	32 10.0	37 0.5	45 10.5	....	40 2.0	11 54 46.0
Eq. intervals	....	+ 0.45	— 44.88	— 22.74	— 44.14	— 43.69
Mean wire	10 31 30.00	10 36 15.22	10 44 25.54	10 54 24.76	11 39 18.34	11 54 2.31
Rate	+ 0.57	+ 0.57	+ 0.58	+ 0.59	+ 0.65	+ 0.67
Level	+ 0.03	+ 0.03	+ 0.07	+ 0.11	+ 0.21	+ 0.21
Collimation	— 5.63	— 6.36	— 6.29	— 6.35	— 6.04	— 6.18
Az. deviation	— 0.09	+ 1.43	+ 1.30	+ 1.35	+ 0.95	+ 1.18
*'s transit	10 31 24.88	10 36 10.89	10 44 21.20	10 54 20.46	11 39 14.11	11 53 58.19
*'s A. R.	7 31 53.76	7 36 39.45	7 44 50.39	7 54 49.79	....	8 54 27.98
Reduction to the catalogue	— 0.30	— 0.62	+ 0.01	+ 0.15	....	+ 0.61
Error of chronometer	2 59 30.82	2 59 30.82	2 59 30.82	2 59 30.82	....	2 59 30.82

Station—Saltos.

Reduction of transits by the method of least squares. Assumed error = — 2h. 59m. 30s.80.

*'s name.	Δ	A	A²	AΔ	Az. Dev.
α Persei	+ 2.79	— 1.033	+ 1.067	— 2.882	+ 3.58
η Tauri	+ 1.63	— 0.312	0.097	0.509	+ 1.08
27 Tauri	+ 0.82	— 0.311	0.097	0.255	+ 1.08
ε Tauri	+ 0.78	— 0.216	0.047	0.168	+ 0.75
α Tauri	+ 0.63	— 0.166	0.028	0.105	+ 0.58
ε Leporis	— 2.12	+ 0.536	0.287	1.136	— 1.86
δ Orionis	— 0.19	+ 0.130	0.017	0.025	— 0.45
α Columbæ	— 3.18	0.796	0.634	2.531	— 2.76
α Orionis	+ 0.22	— 0.004	0.000	0.001	+ 0.01
γ Orionis	+ 0.64	— 0.139	0.019	0.089	+ 0.48
μ Geminorum	+ 0.99	— 0.291	0.084	0.288	+ 1.01
α² Geminorum	+ 2.18	— 0.502	0.252	1.094	+ 1.74
α Can. Min	— 0.41	+ 0.026	0.001	0.011	— 0.09
β Geminorum	+ 0.79	— 0.413	0.171	0.326	+ 1.43
δ Geminorum	+ 1.29	— 0.375	0.141	0.484	+ 1.30
C Cancri	+ 1.48	— 0.390	0.153	0.577	+ 1.35
γ Cancri	+ 1.77	— 0.340	0.116	0.602	+ 1.18
	+16.01	+ 1.488	+ 3.211	—11.083	
	— 5.90	— 4.492			
	+10.11	— 3.004			

$$\left.\begin{aligned} 17\,\epsilon &= 3.004\,a + 10.11 \\ -3.004\,\epsilon + 3.211\,a &= -11.083 \end{aligned}\right\}\ \epsilon = \frac{10.11 + 3.004\,a}{17} = \frac{11.083 + 3.211\,a}{3.004}$$

$$\begin{aligned} 30.370 + 9.024\,a &= 188.411 + 54.587\,a \\ -158.041 &= +\ 45.563\,a \\ a &= -\ 3.468 \\ \epsilon &= -\ 0.02 \\ E &= -\ 2h.\ 59m.\ 30s.82. \end{aligned}$$

Station—Saltos.

January 28.—Moon Culmination. Observer, L. N. Michler; Computer, L. Daser.

I. Wire	40.1	
II. Wire	11 38 57.0	
III. Wire	39 18.5	
IV. Wire	39 40.0	
V. Wire	40 2.0	— 1.60217
		0.03244
		1.63461
		= 43.11 s.
		+ 1.03
		44.14
Interval	— 44.14	
Mean wire	11 39 18.34	
Rate	+ 0.65	
Level	+ 0.21	
Collimation	— 6.04	
Az. dev.	+ 0.95	
Transit	11 39 14.11	
Chro. error	2 59 30.33	
☾'s A. R.	8 39 43.58	at Saltos.
☾'s A. R.	8 39 39.62	at Washington.
	3.96	
Log 3.96	= 0.59770	
Log 3600	= 3.55630	
	4.15400	
Log. ☾'s hourly motion	= 2.18404	
	1.96996	= 93.31 s.

	° ′ ″		
Horizontal parallax	= 0 59 49.7	Sin.	= 8.24064
Latitude	= 7 4 35	Cos.	= 9.99668
Interval (in arc)	= 10 46.65	Sin.	= 7.49625
Declination	= 21 52 13.7	Sec.	= 0.03244
			5.76601

Parallax in A. R. (in arc)	= 12.04″
Parallax in A. R. (in time)	— 0.80 s.

Moon's hourly motion in A. R.	= 2.18404
Interval	= 1.63461
	3.81865
Log 3600	= 3.55630
	= 0.26235

Cor. for ☾'s motion	= + 1.83 s.
Cor. for ☾'s parallax	— 0.80
	+ 1.03

CHRONOMETRICAL ERROR BY MOON CULMINATING STARS.

C Cancri	2 59 30.67
α^2 Geminorum	30.36
γ Orionis	30.64
α Tauri	30.75
η Tauri	30.25
	2 59 30.53

Station—Saltos.

Transit observations, February 15, 1858. Observer, Lieutenant N. Michler; Zenith Telescope by Wurdemann, No. 11; Sidereal Chronometer by Bond & Sons, No. 202; Computer, L. Daser.

	α Aurigæ.	β Tauri.	δ Orionis.	α Columbæ.	α Orionis.	α Argus.
Level	W. 5 E. 29	W. 14 E. 21	W. 6.5 E. 28.5	W. 13 E. 22	W. 8 E. 27	W. 19.5 E. 15.5
Level reversed	W′ 14 E′ 20	W′ 9.5 E′ 24.5	W′ 16.5 E′ 18	W′ 7 E′ 28	W′ 24 E′ 11	W′ 15.5 E′ 19.5
Wire I		8 16 31.5	8 24 11.0		8 46 42.5	9 20 16.0
Wire II	8 5 35.0	16 54.5	24 31.5	8 34 26.5		20 48.5
Wire III			24 51.0			
Wire IV		17 39.0	25 11.5		47 42.5	
Wire V		18 2.0				22 26.50
Eq. intervals	+ 28.32	+ 0.08	+ 39.61	+ 23 82	+ 20.12	+ 33.14
Mean time	8 6 3.32	8 17 16.77	8 24 51.15	8 34 50.32	8 47 32.56	9 21 21.38
Rate	+ 0.38	+ 0.40	+ 0.41	+ 0.42	+ 0.43	+ 0.48
Level	− 0.56	− 0.39	− 0.39	− 0.45	− 0.10	0.0
Collimation	− 8.04	− 6.37	− 5.60	− 6.76	− 5.64	− 9.22
Az. deviation	+ 16.28	+ 7.51	− 2.35	− 14.42	+ 0.07	− 25.76
*'s transit	8 6 11.38	8 17 17.92	8 24 43.22	8 34 29.11	8 47 27.32	9 20 46.88
*'s A. R.	5 6 13.77	5 17 20.45	5 24 46.45	5 34 31.83	5 47 30.46	6 20 49.69
Reduction to the catalogue	− 0.40	+ 0.21	+ 0.44	− 0.07	+ 0.35	+ 0.02
Error of chronometer	2 59 57.21	2 59 57.21	2 59 57.51	2 59 57.21	2 59 57.21	2 59 57.21

Station—Saltos.

Transit observations continued, February 15, 1858. Observer, Lieutenant N. Michler; Zenith Telescope by Wurdemann, No. 11; Sidereal Chronometer by Bond & Sons, No. 202; Computer, L. Daser.

	γ Geminorum.	α Can. Maj.	γ Can. Maj.	δ Geminorum.	β Geminorum.
Level	W. 14 E. 22	W. 19.5 E. 16.5	W. 6 E. 30	W. 18.5 E. 18.5	W. 7 E. 29
Level reversed	W′ 21 E′ 15	W′ 15 E′ 22	W′ 22 E′ 14	W′ 14 E′ 22	W′ 17 E′ 19
Wire I	....	9 38 23.5	9 56 51.5	10 10 55.0	10 35 50.0
Wire II	9 29 11.5	38 44.5	57 11.5	11 16.5	....
Wire III	29 31.5	39 5.0	57 31.5	11 38.0	....
Wire IV	29 52.0	39 26.0	57 52.0	12 00.0	....
Wire V	30 12.5	39 46.5	58 12.5	12 20.5	....
Eq. intervals	— 41.73	....	....	....	+ 45.45
Mean wire	9 29 31.44	9 39 5.10	9 57 31.80	10 11 38.00	10 36 35.45
Rate	+ 0.49	+ 0.50	+ 0.52	+ 0.54	+ 0.57
Level	— 0.03	— 0.06	— 0.26	— 0.14	— 0.42
Collimation	— 5.84	— 5.84	— 5.81	— 6.05	— 6.36
Az. deviation	+ 3.10	— 7.57	— 7.03	+ 5.13	+ 7.48
*'s transit	9 29 29.16	9 38 52.13	9 57 19.22	10 11 37.48	10 36 36.72
*'s A. R.	6 29 32.18	6 38 55.05	6 57 21.62	7 11 40.36	7 36 39.45
Reduction to the catalogue	+ 0.23	+ 0.13	— 0.39	+ 0.09	— 0.06
Error of chronometer	2 59 57.21	2 59 57.21	2 59 57.21	2 59 57.21	2 59 57.21

Station—Saltos.

Reduction of transits by the method of least squares. Assumed error = — 2*h*. 59*m*. 57*s*.

*'s name.	Δ	A	A²	AΔ	Az. Dev.
α Aurigæ	+ 15.67	− 0.899	+ 0.808	− 14.168	+ 16.28
β Tauri	+ 7.04	− 0.415	0.172	2.922	+ 7.56
δ Orionis	− 2.12	+ 0.130	0.017	0.276	− 2.35
α Columbæ	− 15.10	+ 0.796	0.634	12.021	− 14.42
α Orionis	+ 0.11	+ 0.004	0.000	0.000	+ 0.07
α Argus	− 25.95	+ 1.422	2.022	36.901	− 25.76
γ Geminorum	+ 3.12	− 0.171	0.029	0.534	+ 3.10
α Can. Maj	− 7.65	+ 0.418	0.175	3.198	− 7.57
γ Can. Maj	− 7.63	+ 0.388	0.151	2.960	− 7.03
δ Geminorum	+ 5.01	− 0.283	0.080	1.418	+ 5.13
β Geminorum	+ 7.21	− 0.413	0.171	2.978	+ 7.48
	+ 38.16	+ 3.174	+ 4.259	77.376	
	− 58.45	− 2.185			
	− 20.29	+ 0.989			

$$\left.\begin{aligned} 11\,\epsilon + 0.989\,\alpha &= -20.29 \\ +\,0.989\,\epsilon + 4.259\,\alpha &= -77.376 \end{aligned}\right\}\ \epsilon = \frac{-20.29\,\alpha - 0.989\,\alpha}{11} = \frac{-77.376 - 4.259\,\alpha}{0.989}$$

$$\begin{aligned} 20.067 + 0.978\,\alpha &= 851.136 + 46.849\,\alpha \\ -831.069 &= 45.871\,\alpha \\ \alpha &= -18.118 \\ \epsilon &= -0.21 \\ E &= -2h.\ 59m.\ 57s.21. \end{aligned}$$

Station—Saltos.

Altitudes of the Sun for time, (East,) February 15, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Mean Solar Chronometer, by Arnold No. 6220; Computer, L. Daser. Assumed latitude, 7° 4′ 35″; assumed longitude, + 0° 22′ 26″, Washington Observatory. Equation of time, + 14′ 23.6″; Declination, = — 12° 35′ 30.2″.

	U. L.	L. L.	L. L.	L. L.	U. L.
	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
Observed altitude (E)	49 27 25	52 28 5	52 42 20	52 57 55	53 39 40
Sun's semi-diameter	— 16 13.4	+ 16 13.4	+ 16 13.4	+ 16 13.4	— 16 13.4
Parallax	+ 0 5.6	+ 0 5.6	+ 0 5.6	+ 0 5.6	+ 0 5.6
Index Error	+ 2 10.0	+ 2 10.0	+ 2 10.0	+ 2 10.0	+ 2 10.0
Refraction	— 0 50	— 0 44.8	— 0 44.5	— 0 44.1	— 0 43.0
Correction	— 14 48	+ 17 44	+ 17 44	+ 17 45	— 14 41
True altitude = A	49 12 37	52 45 49	53 0 4	53 15 40	53 24 59
Latitude = L	7 4 35	7 4 35	7 4 35	7 4 35	7 4 35
North polar distance = Δ	102 37 34	102 37 20	102 37 19	102 37 17	102 37 17
2 m	158 54 46	162 27 44	162 41 58	162 57 32	163 6 51
m	79 57 23	81 13 52	81 20 59	81 28 46	81 33 25
(m — A)	30 14 46	28 28 3	28 20 55	28 13 06	28 8 26
Log. Cos. m	9.26241	9.18310	9.17724	9.17074	9.16681
Log. Sin. (m—A)	9.70218	9.67821	9.67654	9.67470	9.67360
Log. Sec. L	0.00332	0.00332	0.00332	0.00332	0.00332
Log. cosec. Δ	0.01064	0.01063	0.01063	0.01063	0.01063
Log. ($\sin.^2 \frac{1}{2}$ p)	18.97855	18.87526	18.86773	18.85939	18.85436
Log. sin. ½ p	9.48927′	9.43763	9.43386′	9.42969′	9.42718
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
Hour angle	2 23 45.5	2 7 11.0	2 6 3.5	2 4 49.3	2 4 5.0
Observed time by chronometer	1 55 2.0	2 11 32.8	2 12 42.4	2 13 55.6	2 14 40.0
Apparent noon	4 18 47.5	4 18 43.8	4 18 45.9	4 18 44.9	4 18 45.0
Equation of time	0 14 23.6	0 14 23.6	0 14 23.6	0 14 23.6	0 14 23.6
Error of chronometer	— 4 4 23.9	— 4 4 20.2	— 4 4 22.3	— 4 4 21.3	— 4 4 21.4
Mean					— 4 4 21.8

Station—Saltos.

Circum-meridian altitudes of the Sun's upper limb, January 20, 1858. Observer Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Mean Solar Chronometer by Arnold, No 6220 Computer, L. Daser.

Observed— Circum-meridian altitudes.	Observed— Time by chronometer.	Meridian distance.	k.	m.	Reduction to the meridian.	Circum-meridian altitudes corr. for semi-diameter, parallax, refrac., and index error.	True meridian altitudes deduced.	Latitude.
° ′ ″	h. m. s.	m. s.	″		′ ″	° ′ ″	° ′ ″	° ′ ″
62 43 10	3 57 11.2	19 19.6	733.0	1.30	24 47.0	62 25 46.7	62 50 33.7	7 4 62.1
62 47 30	3 58 44.8	16 46.0	619.5	0.93	20 57.9	62 30 6.7	62 50 64.6	7 4 31.2
62 49 5	3 59 30.8	17 0.0	567.2	0.78	19 12.4	62 31 41.7	62 50 54.1	7 4 41.7
62 51 15	4 0 30.8	16 0.0	502.5	0.61	17 2.2	62 33 51.7	62 50 53.9	7 4 41.9
62 52 10	4 1 2.8	15 28.0	469.5	0.54	15 55.3	62 34 46.7	62 50 42.0	7 4 53.8
62 53 20	4 1 42.0	14 48.8	430.7	0.45	14 36.7	62 35 56.7	62 50 33.4	7 4 62.4
62 58 5	4 4 7.0	12 23.8	301.6	0.22	10 14.7	62 40 41.7	62 50 56.4	7 4 39.4
63 1 5	4 6 8.8	10 22.0	211.0	0.11	7 10.4	62 43 41.7	62 50 52.1	7 4 43.7
63 2 5	4 6 54.8	9 36.0	180.9	0.08	6 9.1	62 44 41.7	62 50 50.8	7 4 45.0
63 4 20	4 8 40.5	7 50.4	120.7	0.04	4 6.4	62 46 56.7	62 50 63.1	7 4 32.7
63 6 45	4 11 11.6	5 19.2	55.6	0.01	1 53.5	62 49 21.7	62 50 75.2	7 4 20.6
63 7 45	4 12 16.4	4 14.4	35.3	0.00	1 12.1	62 50 21.7	62 50 93.8	7 4 2.0
63 8 20	4 14 40.4	1 50.4	6.6	0.00	0 13.5	62 50 56.7	62 50 70.2	7 4 25.6
M.	4 16 30.8							
63 8 40	4 17 20.8	0 50.0	1.4	0.00	0 2.8	62 51 16.7	62 50 79.5	7 4 16.3
63 0 25	4 27 35.2	11 4.4	240.4	0.14	8 11.9	62 43 1.7	62 50 73.6	7 4 22.2
62 56 5	4 30 16.8	13 46.0	372.0	0.34	12 37.6	62 38 41.7	62 50 79.3	7 4 16.5
62 50 55	4 33 0.4	16 29.6	533.8	0.69	18 5.5	62 33 31.7	62 50 97.2	7 3 58.6
62 46 55	4 34 40.4	18 9.6	647.2	1.02	21 54.7	62 29 31.7	62 50 86.4	7 4 9.4
62 44 10	4 35 44.8	19 14.0	725.9	1.28	24 33.5	62 26 46.7	62 50 80.2	7 4 15.6
							62 51 05.2	7 4 30.6

	h. m. s.
Chron. fast of mean time	4 5 6.6
Equation of time	+ 0 11 24.2
Apparent noon	4 16 30.8

Ass. lat. = + 7° 4′ 30′
Declination − 20 4 24.2
Approx. alt. = 62 51 6

2.043

Cos. = 9.99668
Cos. = 9.97278
Sec. = 0.34075
= 0.31021
0.69042
tg. a = 0.29006
8.14 = 0.91048

Semi-diameter = − 16′ 17.4″
Parallax = + 0 4.0
Refraction = − 0 29.9
Index error = − 0 40.0

Station—Saltos.

Circum-meridian altitudes of α Aurigæ, January 24, 1858. Observer, Lieutenant N. Michler; Sextant, by Pistor & Martins, No. 933; Sidereal Chronometer, by Bond & Sons, No. 202; Computer, L. Daser.

Observed— Circum-meridian altitudes.	Observed— Time, by chronometer.	Meridian distances.	k.	m.	Reduction to the meridian.	Circum-meridian altitudes corrected for refraction and index error.	True meridian altitudes deduced.	Latitude.
° ′ ″	h. m. s.	m. s.	″		″	° ′ ″	° ′ ″	° ′ ″
51 13 15	8 1 45.0	4 7.4	33.4	0.00	36.8	51 12 28	51 13 4.8	7 4 15.2
51 14 5	8 3 39.0	2 13.4	9.7	0.00	10.7	51 13 18	51 13 28.7	7 4 39.1
51 14 15	8 5 1.0	51.4	1.4	0.00	1.5	51 13 28	51 13 29.5	7 4 39.9
M. T.	8 5 52.4	.0						
51 14 5	8 6 41.0	48.6	1.3	0.00	1.4	51 13 18	51 13 19.4	7 4 29.8
51 13 55	8 7 45.0	1 52.6	6.9	0.00	7.6	51 13 8	51 13 15.6	7 4 26.0
51 13 35	8 9 28.0	3 35.6	25.3	0.00	27.8	51 12 48	51 13 15.8	7 4 26.2
51 13 25	8 10 38.0	4 45.6	44.5	0.00	49.1	51 12 38	51 13 27.1	7 4 37.5
51 12 45	8 12 33.0	6 40.6	87.5	0.01	136.6	51 11 58	51 13 34.6	7 4 45.0
51 13 40	....	....	26.25	0.00	28.98	51 12 53	51 13 22.0	7 4 32.4
			January	26, 1858.				
51 14 5	8 5 58.0	10.0	0.1	0.00	0.1	51 13 21.4	51 13 21.5	7 4 32.1

	h. m. s.
☆'s A. R.......... =	5 6 14.1
Error of chro.... =	−2 59 38.3
Merid'n passage =	8 5 52.4

	° ′ ″		
Assumed latitude...... =	+7 4 35	Cos. L... =	9.99668
Declination.............. =	+45 51 10.4	Cos. D... =	9.84293
Approx. alt............ =	51 13 25	Sec. A... =	0.20323
	1.1036		0.04284

	″
Refraction ... =	−46.9
Index error.. =	0.0 (+3.3)
	43.6
Refraction.... =	−46.9
Index error.. =	+3.3
	43.6
Declination... =	45 51 10.6

TABLE No. I.

OF TRUE COURSES AND DISTANCES.

COMPUTED BY JACOB SCHMITT.

From station.	To station.	True course.		Distance.		Remarks.
		Protected.	Exposed.	Observed.	Reduced.	
		° ′	° ′	*Feet.*	*Feet.*	
	32	....	....	....	....	Signal at mouth of Caño Coquito.
32	33	S. 41 51 W.		175	175	
33	34	S. 45 21 W.		525	525	
34	35	S. 51 51 W.		375	375	
35	36	S. 19 51 W.		430	430	
36	37	S. 48 36 W.		1950	1929	
37	38	S. 88 36 W.		220	220	
38	39	S. 65 21 W.		1025	1019	
39	40	S. 47 51 W.		1280	1271	
40	41	S. 60 21 W.		730	727	
41	42	S. 36 21 W.		875	870	
42	43	S. 53 21 W.		1110	1103	
43	44	S. 87 51 W.		1120	1113	
44	45	N. 84 9 W.		1070	1064	
45	46	S. 67 21 W.		850	846	Separation of Caño Coquito from Caño Barbacoas.
46	47	S. 85 51 W.		950	945	
47	48	S 56 9 E.		725	721	
48	49		S. 41 21 W.	2910	2648	
49	50		S. 40 51 W.	3240	2923	
50	51		S. 58 21 W.	2290	2128	
51	52		S. 33 39 E.	885	860	Separation of Caño Coco Grande from Caño Barbacoas.
52	53		S. 74 51 W.	5760	4810	
53	54		S. 49 51 W.	3720	3304	
54	55	N. 58 9 W.		3980	3900	
55	56	S. 78 21 W.		3200	3142	
56	57		S. 74 52 W.	2770	2537	
57	58		S. 29 22 W.	4020	3532	
58	59	N. 82 8 W.		3800	3720	Separation of Caño Tarena and Caño Barbacoas.
59	60	S. 49 52 W.		3220	3162	
60	61		S. 19 22 W.	3700	3293	
61	62		S. 73 7 W.	3840	3400	
62	63		S. 42 22 W.	5840	4865	
63	64		N. 85 38 W.	3220	2905	
64	65		S. 75 52 W.	4440	3860	
65	66		S. 74 52 W.	4020	3538	
66	67		S. 6 22 W.	3120	2824	
67	68		S. 29 22 W	4020	3535	
68	69		S. 2 22 W.	5740	4800	
69	70		S. 23 52 W.	4060	3573	
70	71		S. 10 38 E.	4680	4044	
71	72		S. 8 38 E.	4220	3690	
72	73		S. 7 53 E.	3180	2878	
73	74		S. 82 53 W.	2150	2005	
74	75	S. 52 53 W.		2890	2844	
75	76	N. 65 7 W.		2280	2250	
76	77	S. 47 53 W.		4580	4470	
77	78	S 55 37 E.		3740	3665	
78	79	S. 4 53 W.		2335	2305	

TABLE No. I—Continued.

From station.	To station.	True course. Protected.	True course. Exposed.	Distance. Observed.	Distance. Reduced.	Remarks.
		° ′	° ′	*Feet.*	*Feet.*	
79	80	S. 10 22 E.		4680	4560	Separation of Caño Leon or Urabá.
80	81	S. 61 8 W.		2855	2810	
81	82		S. 12 23 W.	7950	6230	
82	83		S. 38 24 W.	7700	6080	
83	84		S. 16 39 W.	8200	6380	Mouth of Rio Tumarador Grande.
84	85		S. 68 24 W.	9100	6907	
85	86		S. 23 25 W.	5430	4598	
86	87		S. 72 25 W.	4480	3893	
87	88	S. 76 25 W.		4100	4010	
88	89	S. 85 25 W.		3385	3325	
89	90		S. 23 55 W.	4480	3893	
90	91		S. 67 25 W.	3900	3444	
91	92		S. 60 25 W.	3900	3444	
92	93		N. 56 5 W.	6600	5370	
93	94		S. 23 25 W.	4420	3840	
94	95		S. 40 5 E.	3780	3360	
95	96		S. 21 26 W.	3140	2840	
96	97		S. 11 34 E.	5600	4700	
97	98		S. 9 56 W.	3220	2905	
98	99	S. 70 34 E.		3780	3705	Boulders on the right shore, opposite the "Playa de las Pulgas."
99	100	S. 26 41 W.		2200	2170	
100	101		S. 24 27 W.	3625	3230	
101	102		N. 51 3 W.	1860	1750	
102	103	N. 82 33 W.		9300	8900	
103	104	S. 7 27 W.		4000	3910	
104	105	S. 58 3 E.		5660	5490	
105	106	S. 56 57 W.		1930	1910	
106	107	S. 11 17 W.		3700	3625	
107	108	S. 5 48 W.		3820	3740	Boca Cacarica on the left.
108	109		S. 17 32 E.	3760	3340	
109	110		S. 45 58 W.	4780	4115	
110	111		S. 9 2 E.	3240	2923	
111	112		S. 0 29 W.	4940	4224	
112	113	S. 81 31 E.		1510	1495	
113	114	S. 7 29 W.		6700	6490	
114	115	N. 88 29 E.		1365	1354	
115	116	S. 5 29 W.		3700	3625	
116	117		S. 23 31 E.	5700	4760	
117	118		S. 18 30 W.	5600	4690	
118	119		S. 28 0 E.	4510	3905	
119	120		S. 14 0 E.	6700	5440	
120	121		S. 22 29 E.	5065	4320	
121	122		S. 6 19 E.	6950	5610	
122	123		S. 23 59 E.	4780	4115	
123	124		S. 14 29 E.	3800	3370	
124	125		S. 63 58 E.	3540	3160	
125	126		S. 44 28 E.	3210	2895	
126	127	S. 81 43 E.		2770	2728	Mouth of Rio Tumaradorcito.
127	128	S. 12 43 E.		2240	2210	
128	129		S. 9 58 E.	3720	3300	
129	130		S. 75 18 W.	3940	3475	
130	131	S. 82 33 W.		4320	4220	
131	132	N. 5 57 W.		3360	3300	
132	133		N. 32 57 W.	3940	3475	
133	134		N. 42 57 W.	3560	3180	
134	135	S. 73 3 W.		5965	5780	

TABLE No. I—Continued.

From station.	To station.	True course. Protected.	True course. Exposed.	Distance. Observed.	Distance. Reduced.	Remarks.
		° ′	° ′	*Feet.*	*Feet.*	
135	136	S. 19 49 W.		4380	4280	Campo Rio Hondo. Hondo village, at south point of mouth of Rio Hondo, coming from the left. Sometimes occupied.
136	137	N. 45 4 E.		903	895	
137	138	S. 62 41 E.		4300	4200	
138	139	S. 71 26 E.		3280	3220	
139	140	S. 12 49 W.		2570	2535	
140	141	S. 40 26 E.		3150	3100	
141	142	S. 21 26 E.		3600	3525	
142	143	N. 64 4 E.		2605	2565	
143	144	N. 83 34 E.		3400	3335	
144	145	N. 77 18 E.		4480	4370	
145	146	S. 31 57 E.		3140	3085	
146	147	S. 43 2 E.		4460	4355	Boca Larga, on the right.
147	148	S. 6 34 W.		4240	4145	
148	149	S. 54 11 E.		3360	3300	
149	150	S. 2 11 E.		4140	4050	
150	151		S. 12 55 E.	3310	2980	
151	152		S. 46 5 W.	2830	2585	
152	153	S. 26 6 W.		2920	2875	
153	154	N. 69 24 W.		2900	2855	
154	155	N. 88 54 W.		2335	2305	
155	156	N. 49 24 W.		2880	2835	
156	157		S. 38 6 W.	2260	2100	
157	158		S. 23 6 W.	3360	3020	Campo Playita Mala.
158	159	S. 28 23 E.		2760	2720	Rio Guachuco from the left.
159	160	S. 58 37 W.		2465	2430	
160	161	S. 15 23 E.		2020	1995	
161	162	S. 78 38 W.		1970	1950	
162	163	S. 19 38 W.		1470	1460	Calle Guachuco, from the left.
163	164	N. 66 52 W.		2655	2615	Playa Massamora on the right.
164	165	S. 38 38 W.		1700	1685	
165	165a	S. 34 39 W.		220	220	
165a	166	S. 33 39 W.		2465	2430	
166	167	S. 54 41 E.		2440	2410	
167	168	S. 2 24 W.		1208	1200	Opposite the village of Sucio.
168	169	N. 34 24 E.		1173	1165	

TABLE No. I—Continued.

Table of true courses and distances.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	*Feet.*					
169	Instr.	N. 36 20 W.	50	40			30	
Instr.	R.H.	N. 35 40 E.	63	51		37		Southwest corner of Señor de la Rosa's house, and Astronomical station.
	B.St.	N. 33 25 E.	90	75		50		Barometrical station
	H.Pt.	N. 47 50 W.	85	57			63	Highest point of bank.
	170	S. 46 6 E.	2420		1678	1744		Closely above the Salaqui—mouth of Rio Truandó.
170	Instr.	N. 6 0 E.	950	945		99		
Instr.	M.S.	S. 50 20 E.	170	....	....	....	....	Upper point of mouth of Rio Sucio.
	171	S. 30 20 E.	2590		2236	1307		
171	Instr.	S. 52 30 W.	1470		895		1166	
Instr.	172	S. 14 10 E.	1540		1493	379		
172	Instr.	S. 15 25 W.	1510		1455		404	Large Sandbeach.
Instr.	173	S. 68 50 E.	1295		469	1207		Opposite Boca Caimanero of Rio Truando.
173	Instr.	S. 61 10 W.	1510		732		1324	
Instr.	174	N. 70 5 W.	485	166			456	
174	Instr.	S. 82 55 W.	1525		192		1513	
Instr.	175	N. 59 0 W.	570	294			488	Channel on the right.
175	Instr.	N. 89 10 W.	1000	13			1000	
Instr.	176	N. 58 5 W.	560	297			475	
176	Instr.	S. 40 25 W.	700		532		455	
Instr.	177	S. 89 20 W.	750		10		750	
177	Instr.	N. 39 35 W.	820	632			522	
Instr.	178	S. 88 25 W.	700		22		700	
178	Instr.	N. 23 4 W.	840	773			329	
Instr.	179	S. 25 11 W.	790		714		337	
179	Instr.	S. 5 34 E.	535		532	51		
Instr.	180	S. 28 26 W.	450		396		215	
180	Instr.	S. 82 56 W.	720		87		715	Channel on the left.
Instr.	181	S. 57 41 W.	960		512		812	Channel on the left.
181	Instr.	S. 27 31 W.	1115		989		515	
Instr.	182	N. 89 19 W.	1100	14			1100	
182	Instr.	S. 30 56 W.	735		630		379	
Instr.	183	S. 83 26 W.	350		40		348	Separation of the Salaqui—channel on the left.
183	Instr.	S. 3 56 W.	610		609		43	
Instr.	184	S. 69 49 E.	720		251	676		Channel on the left.
184	Instr.	S. 46 33 E.	640		444	465		
Instr.	185	S. 75 23 E.	1155		293	1118		
185	Instr.	N. 44 42 E	610	435		428		
Instr	186	S. 59 33 E.	660		337	568		
186	Instr.	S. 62 3 E.	600		283	529		
Instr.	187	S. 12 18 E.	1015		994	216		
187	Instr.	S. 12 47 W.	660		645		146	
Instr.	188	S. 14 18 E.	805		781	198		
188	Instr.	S. 56 18 E.	520		290	432		
Instr.	189	S. 21 18 E.	565		530	205		
189	Instr.	S. 30 48 E.	670		577	344		
Instr.	190	S. 8 27 W.	640		634		94	
190	Instr.	S. 61 42 W.	840		401		737	
Instr.	191	S. 20 57 W.	390		365		139	
191	Instr.	N. 85 34 W.	635	52			633	
Instr.	192	S. 18 13 W.	270		257		83	
192	Instr.	S. 15 43 W.	565		545		152	
Instr.	193	S. 46 2 E.	1120		779	806		
193	Instr.	S. 2 17 E.	550		550	21		

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude.		Departure.		Remarks.
				North.	South.	East.	West.	
		° ′	*Feet.*					
Instr.	194	S. 9 2 E.	680		673	108		Channel on the left.
194	Instr.	S. 16 43 W.	910		872		262	
Instr.	195	S. 26 17 E.	475		427	210		
195	Instr.	N. 7 23 E.	890	884		102		
Instr.	196	N. 19 2 W.	1225	1159			395	
196	Instr.	S. 5 28 W.	670		669		65	
Instr.	197	S. 54 23 W.	550		322		446	
197	Instr.	S. 28 19 W.	890		785		422	
Instr.	198	S. 59 1 E.	805		417	690		Channel on the left.
198	Instr.	S. 65 31 E.	860		359	782		Opposite Campo Abertura.
Instr.	199	S. 51 44 W.	735		458		577	
199	Instr.	N. 85 16 W.	1030	71			1028	
Instr.	200	S. 32 59 W.	750		631		409	
200	Instr.	N. 82 46 W.	1000	129			992	
Instr.	201	S. 5 59 W.	550		549		58	Channel on the left.
201	Instr.	S. 1 45 W.	965		965		29	
Instr.	202	S. 36 0 E.	945		768	556		
202	Instr.	S. 1 45 E.	900		900	28		
Instr.	203	S. 24 30 E.	790		720	327		
203	Instr.	S. 16 50 W.	1525		1461		442	Fishing rancho on the left
Instr.	204	S. 52 51 W.	605		366		481	
204	Instr.	S. 21 16 W.	660		617		240	
Instr.	205	S. 60 1 W.	700		352		606	
205	Instr.	S. 29 31 W.	890		779		439	
Instr.	206	S. 66 31 W.	820		330		754	
206	Instr.	S. 44 46 W.	850		607		600	
Instr.	207	S. 56 16 W.	890		497		740	Fishing rancho on the left
207	Instr.	S. 6 47 W.	1140		1131		135	
Instr.	208	S. 28 47 W.	1020		899		492	
208	Instr.	S 42 13 E.	540		403	364		Channel on the left.
Instr.	209	S. 11 32 W.	1235		1215		250	
209	Instr.	S. 60 13 E.	545		274	474		
Instr.	210	S. 40 48 W.	835		635		547	
210	Instr.	S. 3 48 W.	1040		1040		71	
Instr.	211	S. 25 33 W.	1070		970		463	
211	Instr.	S. 6 27 E.	1310		1305	147		
Instr.	212	S. 29 20 W.	630		554		310	
212	Instr.	S. 19 26 E.	960		910	321		
Instr.	213	S. 30 19 W.	920		799		466	
213	Instr.	S. 19 46 E.	690		652	233		
Instr.	214	S. 49 49 W.	530		346		406	
214	Instr.	S. 8 11 E.	585		581	84		
Instr.	215	S. 71 50 W.	495		157		470	
215	Instr.	S. 0 10 E.	825		825	2		
Instr.	216	S. 47 5 W.	360		246		265	
216	Instr.	S. 19 25 W.	1245		1179		415	
Instr.	217	S. 36 20 W.	960		777		570	
217	Instr.	S 7 50 W.	675		671		93	
Instr.	218	N. 80 21 E.	665	115		658		
218	Instr.	S. 52 54 E.	355		216	282		
Instr.	219	S. 27 6 W.	455		408		208	
219	Instr.	N. 85 49 W.	750	58			750	
Instr.	220	S. 53 46 W.	1170		695		945	
220	Instr.	S. 16 51 W.	700		673		202	
Instr.	221	S. 48 51 W.	730		482		551	
221	Instr.	S. 38 22 W.	670		527		416	
Instr.	222	S. 75 47 W.	385		97		373	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° '	*Feet.*					
222	Instr.	S. 49 2 W.	1100		722		832	
Instr.	223	N. 73 53 W.	870	245			839	Rancho la Clarita on left shore, sometimes occupied. Opposite channel la Clarita.
223	Instr.	S. 30 27 W.	440		381		224	
Instr.	224	N. 56 8 W.	495	280			412	
224	Instr.	S. 78 52 W.	890		176		874	
Instr.	225	S. 0 22 W.	200		200		1	Campo Clarita; channel on the left.
225	Instr.	S. 34 17 W.	375		312		211	
Instr.	226	N. 44 8 W.	410	298			288	
226	Instr.	S. 74 52 W.	425		113		413	
Instr.	227	N. 60 23 W.	320	161			279	
227	Instr.	S. 71 22 W.	245		79		232	
Instr.	228	N. 46 8 W.	530	369			382	
228	Instr.	N. 6 37 E.	390	388		47		Channel on the left.
Instr.	229	N. 60 53 W.	330	162			290	
229	Instr.	S. 47 37 W.	395		269		292	
Instr.	230	S. 82 22 W.	620		85		615	
230	Instr.	S. 56 23 W.	605		339		505	
Instr.	231	S. 34 38 W.	1050		868		599	
231	Instr.	S. 10 7 E.	500		495	89		
Instr.	232	N. 88 23 E.	185	6		185		
232	Instr.	S. 44 23 W.	525		375		368	
Instr.	233	S. 80 23 W.	1070		181		1056	
233	Instr.	S. 83 9 W.	790		99		785	
Instr.	234	S. 0 54 W.	860		860		14	
234	Instr.	S. 75 21 E.	425		110	412		
Instr.	235	S. 20 6 E.	880		829	305		
235	Instr.	S. 55 21 E.	490		281	405		
Instr.	236	S. 7 56 E.	1155		1147	159		
236	Instr.	S. 13 29 W.	605		590		140	
Instr.	237	S. 2 35 E.	420		420	19		
237	Instr.	S. 31 25 W.	445		381		232	
Instr.	238	S. 3 11 W.	1745		1745		98	
238	Instr.	S. 11 11 W.	1190		1170		230	
Instr.	239	S. 39 1 W.	2275		1775		1436	
239	Instr.	S. 8 19 E.	1035		1027	150		
Instr.	240	S. 21 57 W.	2245		2088		842	
240	Instr.	S. 32 27 W.	940		795		505	
Instr.	241	S. 9 58 W.	1800		1775		312	
241	Instr.	S. 38 28 W.	685		539		427	
Instr.	242	S. 11 33 W.	610		600		122	
242	Instr.	S. 45 31 E.	685		480	490		
Instr.	243	S. 24 31 E.	840		765	348		
243	Instr.	S. 14 59 W.	1015		980		265	
Instr.	244	S. 31 29 W.	1680		1440		878	
244	Instr.	S. 2 29 W.	860		860		36	
Instr.	245	S. 38 45 E.	850		666	532		Commencement of the brushwood.
245	Instr.	S. 19 45 W.	1120		1065		378	Channel on the left.
Instr.	246	S. 60 0 E.	470		239	407		Foot of the Palizadas. Commencement of the wood region.
246	Instr.	S. 35 55 E.	290		238	170		Campo Quita Palos.
Instr.	247	S. 16 0 W.	420		406		117	Channel on the right.
247	Instr.	S. 46 30 E.	145		100	105		
Instr.	248	S. 7 55 E.	490		485	70		
248	Instr.	S. 33 45 W.	585		490		325	
Instr.	249	S. 81 45 E.	275		40	272		
249	Instr.	S. 40 30 E.	555		424	361		

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	*Feet.*					
Instr.	250	N. 35 1 E.	50	41		29		
250	Instr.	S. 24 59 E.	455		414	191		
Instr.	251	S. 59 59 E.	235		118	204		
251	Instr.	S. 25 14 E.	225		205	98		Punta Buenaventura.
Instr.	252	S. 71 1 W.	700		231		661	Channel on the right.
252	Instr.	S. 37 31 W.	685		545		417	
Instr.	253	N. 75 31 E.	230	57		223		
253	Instr.	S. 52 44 E.	370		225	295		
Instr.	254	S. 22 1 W.	240		225		90	
254	Instr.	S. 16 58 E.	495		475	145		
Instr.	255	S. 38 7 E.	210		166	130		Channel on the right.
255	Instr.	S. 58 42 W.	370		193		317	
Instr.	256	S. 42 58 E.	205		152	140		Channel on the left.
256	Instr.	S. 21 28 E.	970		906	355		
Instr.	257	S. 42 18 W.	270		201		181	
257	Instr.	S. 12 42 E.	330		323	74		Commencement of the labyrinth of islands.
Instr.	258	S. 36 33 W.	1155		931		690	
258	Instr.	S. 36 33 W.	230		186		137	
Instr.	259	S. 23 3 W.	385		355		150	
259	Instr.	S. 5 3 E.	305		305	27		
Instr.	260	S. 0 26 E.	790		790	6		Barometrical station.
260	Instr.	S. 55 19 W.	535		306		440	
Instr.	261	N. 42 11 W.	90	67			61	
261	Instr.	S. 38 49 W.	240		188		150	
Instr.	262	S. 54 49 W.	385		224		314	
262	Instr.	S. 47 34 W.	310		211		229	
Instr.	263	N. 74 11 W.	100	27			96	
263	Instr.	S. 53 4 W.	290		175		231	
Instr.	264	S. 27 4 W.	680		608		310	Campo las Isletas.
264	Instr.	S. 7 4 W.	410		410		51	
Instr.	265	S. 48 35 W.	195		130		146	
265	Instr.	S. 4 25 E.	340		340	25		
Instr.	266	S. 37 35 W.	665		530		407	
266	Instr.	S. 8 40 E.	320		318	50		
Instr.	267	S. 26 20 W.	385		348		171	
267	Instr.	S. 22 35 W.	550		510		211	
Instr.	268	S. 26 25 E.	340		305	152		
268	Instr.	S. 11 40 E.	195		191	43		
Instr.	269	S. 7 9 E.	400		400	51		
269	Instr.	S. 62 6 W.	910		428		805	
Instr.	270	S. 39 39 E.	340		262	217		
270	Instr.	S. 33 21 W.	515		433		285	
Instr.	271	S. 2 38 E.	385		385	21		
271	Instr.	S. 24 52 W.	225		207		96	
Instr.	272	S. 5 7 W.	275		275		25	
272	Instr.	S. 33 52 W.	680		565		380	
Instr.	273	S. 79 23 W.	140		26		138	
273	Instr.	S. 8 3 W.	215		215		30	
Instr.	274	S. 68 8 W.	440		166		410	
274	Instr.	S. 5 23 W.	185		185		18	
Instr.	275	S. 63 9 W.	540		245		482	
275	Instr.	N. 66 39 W.	455	183			418	
Instr.	276	S. 83 39 W.	280		32		280	
276	Instr.	S. 74 39 W.	575		155		555	
Instr.	277	S. 23 9 W.	170		157		67	
277	Instr.	S. 88 9 W.	365		14		365	
Instr.	278	S. 70 40 W.	385		130		363	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	*Feet.*					
278	Instr.	S. 14 25 W.	190		186		50	
Instr.	279	S. 76 40 W.	145		34		141	
279	Instr.	S. 70 55 W.	330		110		310	
Instr.	280	S. 73 10 W.	720		210		692	Campo Resumpcion. Opposite deserted Indian rancho.
280	Instr.	S. 70 40 W.	735		245		695	
Instr.	281	N. 89 49 W.	990	4			990	
281	Instr.	N. 85 4 W.	595	54			593	
Instr.	282	N. 13 56 E.	70	68		17		Level raised to the river banks.
282	Instr.	S. 67 46 W.	640		245		595	
Instr.	283	S. 72 11 W.	290		90		278	
283	Instr.	S. 87 41 W.	520		25		520	
Instr.	284	N. 83 4 W.	220	26			219	
284	Instr.	N. 89 28 W.	260				260	
Instr.	285	S. 75 22 W.	480		125		466	
285	Instr.	S. 74 27 W.	360		100		348	
Instr.	286	S. 78 12 W.	290		62		285	
286	Instr.	S. 62 43 W.	490		228		435	
Instr.	287	S. 88 43 W.	265		5		265	
287	Instr.	S. 69 13 W.	195		70		183	
Instr.	288	S. 42 3 W.	535		400		360	
288	Instr.	S. 86 23 W.	270		19		270	
Instr.	289	S. 31 28 W.	300		258		157	
289	Instr.	S. 68 43 W.	365		134		340	
Instr.	290	S. 15 2 E.	395		383	103		
290	Instr.	N. 75 36 W.	350	90			340	
Instr.	291	S. 72 14 W.	435		136		415	
291	Instr.	N. 53 36 W.	660	394			532	
Instr.	292	S. 75 4 W.	245		66		238	
292	Instr.	N. 63 16 W.	210	96			190	
Instr.	293	S. 66 24 W.	235		95		216	
293	Instr.	S. 84 59 W.	440		42		440	
Instr.	294	S. 66 44 W.	400		160		368	
294	Instr.	S. 88 59 W.	195		2		195	
Instr.	295	S. 56 15 W.	555		310		463	
295	Instr.	S. 18 45 W.	205		197		69	
Instr.	296	S. 71 55 W.	195		61		186	
296	Instr.	S. 36 30 W.	315		254		188	
Instr.	297	S. 77 15 W.	310		70		302	
297	Instr.	S. 50 15 W.	415		269		320	
Instr.	298	S. 79 45 W.	270		49		266	
298	Instr.	S. 44 25 W.	295		212		207	
Instr.	299	S. 4 55 W.	260		260		21	
299	Instr.	S. 45 15 E.	190		135	135		
Instr.	300	S. 38 45 E	40	....	....	....	....	Campo las Palizadas, called First Camp in report.
	301	S. 33 15 W.	110		92		60	
301	Instr.	N. 76 25 W.	100	24			97	
Instr.	B. St.	N. 39 25 W.	40	....	....	....	....	Barometrical station.
	302	S. 53 35 W.	160		102		124	
302	Instr.	S. 80 45 W.	260		42		257	
Instr.	303	N. 55 45 W.	215	122			178	
303	Instr.	S. 78 56 W.	215		42		211	
Instr.	304	N. 37 24 W.	180	143			110	
304	Instr.	N. 76 14 W.	350	85			340	
Instr.	305	N. 60 4 W.	160	80			139	
305	Instr.	N. 65 36 E.	130	54		118		
Instr.	306	N. 59 4 W.	220	114			189	
306	Instr.	N. 82 24 W.	110	15			109	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	*Feet.*					
Instr.	307	N. 86 14 W.	150	10			150	
307	Instr.	N. 15 24 W.	110	106			29	
Instr.	308	N. 68 44 W.	190	70			177	
308	Instr.	N. 70 24 W.	430	148			406	
Instr.	309	S. 74 7 W.	150		41		144	
309	Instr.	N. 37 43 W.	235	187			144	
Instr.	310	S. 73 37 W.	80		23		77	
310	Instr.	N. 58 33 W.	375	199			319	
Instr.	311	S. 89 27 W.	325		2		325	
311	Instr.	N. 52 33 W.	15	9			12	
Instr.	312	N. 50 3 W.	240	155			185	
312	Instr.	S. 72 7 W.	230		71		219	
Instr.	313	N. 73 43 W.	230	65			221	
313	Instr.	N. 61 3 W.	155	75			136	
Instr.	314	S. 78 47 W.	210		41		206	
314	Instr.	N. 58 3 W.	395	211			335	
Instr.	315	S. 83 17 W.	420		52		418	
315	Instr.	N. 73 43 W.	510	145			491	
Instr.	316	S. 63 37 W.	240		107		215	
316	Instr.	N. 81 53 W.	130	19			129	
Instr.	317	S. 52 18 W.	295		181		234	
317	Instr.	N. 45 12 W.	200	142			142	
Instr.	318	N. 10 27 W.	150	148			27	
318	Instr.	S. 82 18 W.	195		26		193	
Instr.	319	N. 74 52 W.	210	55			203	
319	Instr.	N. 74 32 W.	280	75			270	Island.
Instr.	320	N. 44 57 W.	300	213			213	
320	Instr.	S. 86 48 W.	585		36		585	
Instr.	321	N. 86 42 W.	340	21			340	
321	Instr.	N. 48 37 W.	220	146			166	
Instr.	322	S. 81 28 W.	200		30		198	
322	Instr.	S. 40 52 E.	90		68	59		
Instr.	323	N. 86 42 W.	820	51			820	
323	Instr.	S. 89 3 W.	470		8		470	
Instr.	324	N. 37 47 W.	280	222			172	
324	Instr.	N. 32 12 W.	135	115			72	
Instr.	325	N. 44 42 W.	260	185			184	
325	Instr.	N. 16 3 E.	190	183		53		
Instr.	326	N. 35 11 W.	570	470			330	
326	Instr.	N. 75 46 W.	340	85			330	On left shore, in Plantain plantation.
Instr.	327	S. 61 9 W.	130		63		114	
327	Instr.	S. 84 29 W.	530		55		530	
Instr.	328	N. 74 11 W.	135	37			130	
328	Instr.	N. 54 41 W.	575	335			471	
Instr.	329	S. 47 39 W.	510		348		378	
329	Instr.	S. 65 49 W.	335		140		305	Tambo José Maria Tocame, on left shore.
Instr.	330	N. 62 41 W.	50	23			45	
330	Instr.	S. 73 54 W.	95		27		91	
Instr.	331	S. 85 54 W.	450		35		450	
331	Instr.	N. 81 56 W.	370	55			368	
Instr.	332	S. 38 59 W.	125		97		79	
332	Instr.	S. 29 0 W.	500		440		242	
Instr.	333	N. 81 10 W.	290	45			287	
333	Instr.	N. 82 25 W.	330	46			327	
Instr.	334	N. 82 40 W.	250	32			248	
334	Instr.	N. 79 15 W.	110	21			108	
Instr.	335	N. 63 25 W.	205	92			184	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	*Feet.*					
335	Instr.	N. 80 25 W.	115	19			113	
Instr.	336	N. 80 10 W.	335	60			330	
336	Instr.	N. 47 40 W.	430	292			319	
Instr.	337	N. 81 10 W.	425	69			422	
337	Instr.	N. 73 10 W.	430	127			414	
Instr.	338	S. 68 1 W.	110		41		102	
338	Instr.	S. 54 31 W.	250		146		204	
Instr.	339	N. 75 29 W.	280	71			271	
339	Instr.	S. 74 56 W.	80		21		77	
Instr.	340	S. 76 21 W.	495		120		480	
340	Instr.	N. 42 9 W.	480	358			322	
Instr.	341	S. 48 21 W.	290		194		218	
341	Instr.	N. 52 39 W.	410	251			327	
Instr.	342	S. 32 56 W.	265		223		145	
342	Instr.	S. 75 31 W.	405		104		394	
Instr.	343	S. 41 36 W.	200		150		133	
343	Instr.	N. 78 19 W.	315	68			310	
Instr.	344	S. 29 11 W.	380		334		185	
344	Instr.	S. 42 6 W.	160		119		108	
Instr.	345	S. 46 56 W.	710		489		519	
345	Instr.	S. 7 56 W.	160		159		22	Level lowered down to the water's edge.
Instr.	346	S. 54 37 W.	740		431		605	
346	Instr.	S. 20 37 W.	160		150		57	
Instr.	347	S. 70 7 W.	220		75		207	
347	Instr.	S. 30 12 W.	400		348		200	
Instr.	348	N. 62 18 W.	205	96			182	
348	Instr.	S. 58 22 W.	365		193		310	
Instr.	349	N. 14 8 W.	330	322			80	
349	Instr.	N. 77 23 W.	755	168			738	
Instr.	350	N. 20 18 W.	260	245			90	
350	Instr.	N. 64 38 W.	395	170			357	
Instr.	351	N. 50 53 W.	160	102			124	
351	Instr.	N. 60 28 W.	170	84			148	
Instr.	352	N. 35 28 W.	390	320			226	
352	Instr.	S. 87 32 W.	335		15		335	
Instr.	353	N. 46 28 W.	220	155			157	Great palisade.
353	Instr.	N. 64 53 W.	260	111			236	
Instr.	354	N. 6 38 W.	120	120			14	
354	Instr.	N. 85 3 W.	130	11			129	
Instr.	355	N. 11 8 W.	265	263			51	
355	Instr.	N. 89 32 W.	330	3			330	
Instr.	356	N. 0 7 W.	225	225				
356	Instr.	N. 73 27 W.	380	112			365	
Instr.	357	S. 58 18 W.	215		114		183	
357	Instr.	S. 83 53 W.	75		8		75	
Instr.	358	S. 62 23 W.	695		325		615	Great palisade.
358	Instr.	S. 67 33 W.	590		229		546	End of the labyrinth of islands. Head of the palizadas.
Instr.	359	S. 3 28 W.	890		889		54	
*359	Instr.	S. 39 23 W.	355		278		225	Channel on the right.
Instr.	360	N. 83 36 W.	760	88			756	
360	Instr.	S. 35 4 W.	655		540		378	
Instr.	361	S. 0 51 E.	680		680	10		
361	Instr.	S. 2 26 W.	365		365		15	
Instr.	362	S. 87 14 W.	875		46		875	Channel on the left.
362	Instr.	S. 39 0 W.	690		539		434	Channel on the left.
Instr.	363	S. 75 5 W.	820		213		792	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° '	Feet.					
363	Instr.	S. 30 30 W.	1245		1076		632	
Instr.	364	S. 63 55 W.	970		430		871	
364	Instr.	S. 17 45 E.	690		659	210		Last channel on the left.
Instr.	365	S. 73 15 E.	325		96	311		
365	Instr.	S. 1 20 W.	540		540		12	
Instr.	366	S. 36 26 W.	1010		817		602	
366	Instr.	S. 8 6 W.	690		685		99	
Instr.	367	S. 31 16 W.	1260		1081		655	
367	Instr.	S. 3 1 W.	610		610		31	
Instr.	368	S. 58 36 W.	430		228		368	
368	Instr.	S. 13 12 W.	390		380		89	
Instr.	369	S. 75 52 W.	1260		311		1223	
369	Instr.	S. 22 32 W.	1280		1185		493	
Instr.	370	S. 54 8 W.	860		507		698	
370	Instr.	N. 54 47 W.	760	441			621	
Instr.	371	S. 23 58 W.	730		671		298	
371	Instr.	S. 12 13 W.	1410		1380		300	
Instr.	372	S. 86 2 E.	1150		82	1147		
372	Instr.	S. 72 37 E.	760		231	726		
Instr.	373	S. 12 8 W.	880		864		184	
373	Instr.	S. 33 38 W.	1015		850		564	
Instr.	374	S. 23 54 W.	830		762		338	
374	Instr.	S. 57 29 W.	740		400		623	Campo de Caiman. Plantain-plantation.
Instr.	375	S. 27 9 W.	465		416		212	
375	Instr.	N. 25 36 W.	870	788			376	
Instr.	376	N. 80 21 W.	780	132			770	
376	Instr.	S. 58 29 W.	1190		624		1014	
Instr.	377	S. 18 1 E.	960		915	297		
377	Instr.	S. 27 46 E.	550		490	258		
Instr.	378	S. 36 9 W.	755		613		447	
378	Instr.	S. 86 29 W.	300		18		300	
Instr.	379	S. 53 24 W.	450		271		362	
379	Instr.	N. 62 26 W.	845	395			750	
Instr.	380	N. 7 36 W.	1155	1145			150	
380	Instr.	S. 65 49 W.	830		343		758	
Instr.	381	S. 19 45 W.	860		812		291	
381	Instr.	S. 22 40 E.	1250		1155	484		
Instr.	382	S. 64 30 W.	550		240		498	
382	Instr.	N. 42 15 W.	875	650			590	
Instr.	383	S. 22 20 W.	1960		1820		746	
383	Instr.	N. 38 15 W.	475	375			295	
Instr.	384	S. 82 15 W.	910		125		904	
384	Instr.	S. 49 50 W.	420		275		321	
Instr.	385	N. 54 25 W.	550	322			448	
385	Instr.	N. 87 30 W.	1190	55			1189	
Instr.	386	S. 73 25 W.	375		110		359	
386	Instr.	N. 48 10 W.	1275	853			951	
Instr.	387	S. 83 40 W.	1020		115		1015	Rio Salado from the left.
								Island and rapids.
387	Instr.	S. 3 29 E.	780		780	47		First white sedimental clay-rock.
Instr.	388	S. 49 24 E.	825		539	625		
388	Instr.	S. 16 59 E.	475		457	140		
Instr.	389	S. 62 1 W.	525		248		463	
389	Instr.	S. 19 31 W.	1090		1030		365	
Instr.	390	S. 48 46 W.	630		418		475	
390	Instr.	S. 24 31 W.	580		530		241	
Instr.	391	N. 29 44 W.	530	463			264	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude.		Departure.		Remarks.
				North.	South.	East.	West.	
		° ′	*Feet.*					
391	Instr.	N. 28 1 E.	245	219		115		
Instr.	392	N. 72 59 W.	750	222			717	
392	Instr.	S. 0 59 E.	1100		1100	19		
Instr.	393	S. 36 2 W.	1120		910		660	
393	Instr.	N. 84 13 W.	1540	158			1533	
Instr.	394	N. 76 58 W.	1000	230			975	
394	Instr.	S. 89 2 W.	1280		25		1280	
Instr.	395	S. 76 2 W.	1155		281		1121	
395	Instr.	N. 87 43 W.	630	29			630	
Instr.	396	S. 66 18 W.	610		248		560	
396	Instr.	S. 89 53 W.	800		1		800	
Instr.	397	S. 60 33 W.	1200		593		1045	First brown sedimental rock.
397	Instr.	S. 26 33 W.	465		419		209	
Instr.	398	S. 59 3 W.	1120		579		962	
398	Instr.	S. 22 48 W.	1365		1262		530	
Instr.	399	S. 76 48 W.	1070		248		1042	
399	Instr.	S. 49 18 W.	800		525		606	
Instr.	400	S. 26 18 W.	680		613		301	
400	Instr.	S. 55 48 W.	550		311		455	
Instr.	401	S. 35 23 W.	680		555		395	
401	Instr.	S. 59 18 W.	860		443		740	
Instr.	402	S. 89 3 W.	820		16		820	
402	Instr.	S. 73 18 W.	620		180		597	Foot of the rapids.
Instr.	403	S. 33 3 W.	1075		905		588	
403	Instr.	N. 57 27 W.	480	260			405	
Instr.	404	N. 19 57 W.	665	628			227	First metamorphic rock.
404	Instr.	N. 53 57 W.	510	302			413	Quebrada peña baja; (creek from the left.)
Instr.	405	S. 75 48 W.	1365		338		1324	
405	Instr.	S. 52 49 W.	1070		651		854	
Instr.	406	N. 69 11 W.	650	234			608	
406	Instr.	N. 22 56 W.	105	97			41	
Instr.	407	S. 82 34 W.	480		65		476	
407	Instr.	N. 82 26 W.	260	35			258	
Instr.	408	N. 63 26 W.	85	38			76	Campo Pie de los Saltos.
408	Instr.	N. 26 41 W.	60	54			27	
Instr.	409	N. 16 11 W.	290	281			81	
409	Instr.	N. 25 26 W.	120	109			52	
Instr.	O. H.	S. 14 4 W.	436		423		105	Observatory Hill.
409	Instr.	N. 57 16 W.	85	46			71	
Instr.	1	S. 82 4 W.	310		46		307	
1	Instr.	N. 78 26 W.	515	106			506	
Instr.	2	S. 55 34 W.	345		198		285	
2	Instr.	S. 5 34 W.	390		389		46	
Instr.	3	S. 8 4 W.	100		99		14	Rio Escalero, or Calderon, from the left.
3	Instr.	S. 15 34 W.	670		648		180	
Instr.	4	S. 87 49 W.	150		6		150	
4	Instr.	N. 69 11 W.	270	99			252	
Instr.	5	S. 51 49 W.	230		145		182	On large fall.
5	Instr.	S. 53 19 W.	180		108		145	
Instr.	6	S. 26 11 E.	460		415	203		
6	Instr.	S. 88 41 E.	440		12	440		Campo de los Saltos.
Instr.	7	S. 3 49 W.	750		749		51	
7	Instr.	S. 39 19 W.	210		163		134	
Instr.	8	S. 23 26 E	360		332	144		
8	Instr.	S. 48 34 W.	385		259		289	
Instr.	9	S. 24 4 W.	600		550		246	
9	Instr.	S. 68 49 W.	320		118		299	
Instr.	10	S. 42 19 W.	1020		759		688	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	*Feet.*					
10	Instr.	S. 19 34 W.	680		643		227	
Instr.	11	S. 5 41 E.	510		508	52		
11	Instr.	S. 23 19 W.	840		774		333	Campo El Puerto 'del Truandó Quebrada peña alta, (creek from the left.
Instr.	12	S. 57 34 W.	1010		545		854	Large quartz boulders in the river.
12	Instr.	S. 69 34 W.	450		160		422	
Instr.	13	S. 85 34 W.	645		55		644	
13	Instr.	S. 23 34 W.	820		754		328	
Instr.	14	S. 27 31 E.	380		339	175		
14	Instr.	S. 2 14 W.	650		650		25	Recommencement of the alluvial banks.
Instr.	15	S. 48 34 W.	735		489		552	
15	Instr.	N. 74 41 W.	750	200			723	
Instr.	16	N. 27 56 W.	1250	1108			586	
16	Instr.	N. 88 26 W.	590	18			590	
Instr.	17	S. 31 4 W.	400		345		206	
17	Instr.	S. 56 19 W.	850		475		707	Head of the Truandó Falls
Instr.	18	S. 72 35 W.	540		164		516	
18	Instr.	S. 33 50 W.	620		519		346	Rocky Island. Rapids.
Instr.	19	S. 87 50 W.	505		20		505	Dry branch from the left.
19	Instr.	S. 14 35 W.	1350		1310		340	
Instr.	20	S. 43 35 W.	450		328		310	
20	Instr.	N. 88 40 W.	945	25			945	
Instr.	21	S. 48 5 W.	580		390		432	
21	Instr.	S. 18 5 W.	1090		1040		338	
Instr.	22	S. 39 5 W.	810		630		510	
22	Instr.	S. 14 5 W.	1120		1090		273	
Instr.	23	S. 0 25 E.	520		520	4		
23	Instr.	S. 37 50 W.	1080		855		663	
Instr.	24	S. 56 5 W.	945		530		785	Creek from the right.
24	Instr.	S. 68 5 W.	620		235		575	
Instr.	25	S. 3 5 W.	890		888		50	
25	Instr.	S. 41 25 E.	525		396	348		
Instr.	26	S. 10 25 E.	870		858	158		Playa de la Wunga.
26	Instr.	N. 57 25 W.	1420	765			1200	Rapids.
Instr.	27	S. 69 40 W.	670		235		636	
27	Instr.	N. 77 10 W.	1285	286			1254	
Instr.	28	S. 33 5 W.	1190		1000		650	
28	Instr.	S. 33 40 W.	600		500		332	
Instr.	29	S. 70 35 W.	530		180		500	Tambo de José; camp.
29	Instr.	N. 60 50 W.	540	265			470	Mouth of Rio Nercua.
Instr.	30	N. 45 5 E.	800	568		568		
30	Instr.	N. 52 15 E.	480	295		380		
Instr.	31	N. 54 20 W.	760	446			617	
31	Instr.	S. 51 55 W.	425		264		335	
Instr.	32	S. 13 5 W.	720		704		161	
32	Instr.	N. 84 30 W.	375	40			374	
Instr.	33	N. 36 45 E.	640	516		383		
33	Instr.	N. 9 15 W.	240	239			40	
Instr.	34	N. 41 5 E.	615	466		406		
34	Instr.	N. 11 40 W.	280	276			58	
Instr.	35	S. 61 25 W.	510		246		449	
35	Instr.	N. 24 40 W.	405	370			170	
Instr.	36	N. 10 35 E.	370	364		68		
36	Instr.	S. 77 0 W.	850		194		829	
Instr.	37	S. 20 45 W.	560		526		198	
37	Instr.	S. 78 50 W.	670		132		659	
Instr.	38	S. 30 5 W.	510		443		256	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude.		Departure.		Remarks.
				North.	South.	East.	West.	
		° '	*Feet.*					
38	Instr.	N. 80 55 W.	125	20			123	
Instr.	39	N. 13 40 W.	365	356			87	
39	Instr.	N. 46 30 W.	225	156			164	
Instr.	40	S. 53 5 W.	600		361		480	
40	Instr.	N. 5 0 E.	280	279		25		
Instr.	41	N. 23 5 E.	415	385		162		Rio Grandó, (Oodor,) from the right.
41	Instr.	N. 83 0 W.	540	70			537	
Instr.	42	N. 1 55 E.	600	600		20		
42	Instr.	N. 35 25 W.	250	205			144	
Instr.	43	N. 23 6 E.	610	563		240		
43	Instr.	S. 80 6 W.	280		51		277	
Instr.	44	S. 33 36 W.	450		377		250	
44	Instr.	N. 70 54 W.	490	164			463	
Instr.	45	N. 31 59 W.	305	260			162	Great Palisade.
45	Instr.	N. 4 14 W.	70	70			5	
Instr.	46	N. 50 1 E.	425	276		328		
46	Instr.	N. 20 54 W.	355	334			128	
Instr.	47	S. 63 36 W.	400		179		359	
47	Instr.	S. 60 51 W.	190		93		166	
Instr.	48	N. 14 24 W.	445	433			112	
48	Instr.	N. 62 54 W.	290	133			259	
Instr.	49	N. 8 24 W.	275	273			40	
49	Instr.	S. 61 21 W.	570		275		503	
Instr.	50	N. 58 54 W.	350	182			300	
50	Instr.	N. 27 9 W.	450	403			206	
Instr.	51	N. 78 51 E.	425	85		418		
51	Instr.	N. 24 24 W.	630	575			262	
Instr.	52	N. 18 6 E.	350	334		109		
52	Instr.	N. 47 14 W.	500	342			368	
Instr.	53	N. 87 39 W	460	20			460	
53	Instr.	S. 33 6 W.	435		365		238	
Instr.	54	N. 68 14 W.	310	118			290	Campo Agua Caliente.
54	Instr.	N. 10 46 E.	385	380		73		
Instr.	55	N. 3 4 W.	600	600			32	Island. Great bend.
55	Instr.	S. 50 16 W.	360		233		276	
Instr.	56	S. 88 21 W.	495		15		495	
56	Instr.	S. 23 6 W.	395		365		155	Hot spring on right bank.
Instr.	57	N. 79 34 W.	390	73			384	
57	Instr.	N. 8 46 E.	320	318		50		
Instr.	58	N. 42 36 E.	325	242		220		
58	Instr.	N. 22 59 W.	340	315			133	
Instr.	59	S. 87 31 W.	590		28		590	
59	Instr.	N 65 24 W.	470	197			428	
Instr.	60	N. 35 24 W.	205	170			120	
60	Instr.	N. 83 26 E.	800	94		795		
Instr.	61	N. 30 24 W.	415	361			212	
61	Instr.	N. 29 54 W.	650	565			324	
Instr.	62	N. 20 36 E.	465	438		163		
62	Instr.	S. 81 1 W.	665		106		658	
Instr.	63	N. 51 14 W.	960	603			750	
63	Instr.	N. 21 21 E.	245	230		89		Rio Equebrador from the right.
Instr.	64	N. 78 51 E.	330	66		324		
64	Instr.	N. 36 11 E.	390	315		230		
Instr.	65	S. 69 29 E.	805		285	755		
65	Instr.	S. 81 34 E.	290		45	288		
Instr.	66	N. 32 36 E.	350	296		188		
66	Instr.	N. 15 9 W.	400	387			105	
Instr.	67	N. 30 36 E.	560	485		285		Rancho on left bank.

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	Feet.					
67	Instr.	N. 72 24 W.	270	82			258	
Instr.	68	S. 82 6 W.	280		39		277	
68	Instr.	N. 13 44 W.	320	312			76	
Instr.	69	N. 42 11 E.	410	305		276		
69	Instr.	N. 76 26 E.	190	45		185		
Instr.	70	N. 0 54 W.	810	810			10	
70	Instr.	N. 0 9 W.	120	120				Rancho on left bank.
Instr.	71	N. 79 24 W.	890	165			875	Tributary from the left, 20 feet wide.
71	Instr.	N. 24 31 E.	280	255		116		
Instr.	72	N. 46 16 E.	210	147		152		
72	Instr.	N. 54 29 W.	620	362			505	
Instr.	73	N. 19 16 E.	450	427		149		
73	Instr.	N. 65 14 W.	415	175			378	
Instr.	74	S. 69 16 W.	210		75		197	
74	Instr.	N. 66 59 W.	555	220			511	
Instr.	75	N. 59 19 W.	660	341			568	
75	Instr.	N. 60 34 W.	500	248			434	
Instr.	76	N. 51 44 W.	300	187			236	Island.
76	Instr.	N. 9 39 W.	395	391			68	
Instr.	77	N. 41 16 E.	535	405		355		Tributary from the right.
77	Instr.	S. 87 24 E.	755		29	755		
Instr.	78	S. 46 39 E.	540		373	395		Island.
78	Instr.	S. 74 39 E.	500		134	482		
Instr.	79	N. 82 6 E.	485	70		480		
79	Instr.	N. 7 44 W.	370	368			50	
Instr.	80	S. 72 26 W.	760		233		725	Campo Playa Bonita.
80	Instr.	N. 2 19 W.	330	330			13	
Instr.	81	N. 36 11 E.	550	445		325		
81	Instr.	N. 83 21 E.	350	45		348		
Instr.	82	N. 54 36 E.	450	263		368		
82	Instr.	N. 78 34 W.	450	92			442	
Instr.	83	N. 4 39 W.	290	290			20	
83	Instr.	N. 20 6 E.	610	574		210		
Instr.	84	N. 28 54 W.	1070	940			518	
84	Instr.	N. 21 39 W.	210	197			78	
Instr.	85	N. 86 24 W.	320	23			320	Tributary from the left.
85	Instr.	N. 28 49 W.	760	669			368	
Instr.	86	N. 51 1 E.	340	215		265		
86	Instr.	N. 68 16 E.	250	95		231		
Instr.	87	N. 12 54 W.	435	426			98	
87	Instr.	N. 41 39 W.	365	275			245	
Instr.	88	N. 34 24 W.	235	195			134	
88	Instr.	S. 27 56 W.	390		347		183	
Instr.	89	S. 17 9 E.	330		317	98		
89	Instr.	S. 62 46 W.	940		433		836	
Instr.	90	N. 22 24 W.	270	250			103	
90	Instr.	N. 9 1 E.	455	451		72		
Instr.	91	N. 46 34 W.	295	205			215	Rio Pavarador from the left, 40 feet wide.
91	Instr.	N. 82 24 W.	640	87			634	
Instr.	92	N. 3 54 W.	450	450			30	
92	Instr.	N. 14 41 E.	990	961		252		
Instr.	93	N. 22 54 W.	890	822			347	
93	Instr.	N. 51 4 W.	860	544			670	
Instr.	94	S. 89 51 W.	525		2		525	Tributary from either side.
94	Instr.	N. 42 24 W.	645	478			435	Island.
Instr.	95	N. 33 4 W.	430	362			235	
95	Instr.	N. 21 36 E.	760	710		280		
Instr.	96	N. 21 54 W.	965	900			360	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	*Feet.*					
96	Instr.	S. 74 26 W.	530		144		511	First hill in sight.
Instr.	97	N. 42 54 W.	690	508			470	
97	Instr.	S. 89 6 W.	445		8		445	
Instr.	98	N. 44 9 W.	450	325			313	
98	Instr.	N. 5 54 W.	380	379			40	
Instr.	99	N. 67 54 W.	670	254			620	
99	Instr.	N. 39 19 W.	625	485			398	
Instr.	100	N. 66 54 W.	720	285			664	
100	Instr.	N. 19 44 W.	305	290			103	
Instr.	101	N. 0 9 W.	730	730			2	
101	Instr.	N. 39 24 W.	390	302			248	
Instr.	102	N. 64 4 W.	630	279			568	
102	Instr.	N. 45 49 W.	750	525			539	
Instr.	103	N. 1 36 E.	645	645		17		Campo Boca Abaja. Lower mouth of Rio Hingador.
103	Instr.	N. 35 29 W.	210	172			121	
Instr.	104	N. 86 24 W.	355	23			354	Campo Boca Ariba. Upper mouth of Rio Hingador.
104	Instr.	S. 83 50 W.	500		56		498	
Instr.	105*a*	N. 6 25 W.	440	438			50	
105*a*	Instr.	N. 20 15 E.	735	692		256		Tambo de Antonio. Indian trail.
Instr.	106*a*	N. 10 25 W.	410	407			75	Astronomical station
106*a*	L. St.	N. 17 55 E.	445	425		136		Last station on the Nercua.
	Instr.	S. 53 5 E.						
Instr.	B. St.	S. 67 0 E.	....	....	....	....	....	Barometrical station.
104	Instr.	S. 54 21 W.	200		119		162	
Instr.	105	S. 20 39 E.	185		174	65		Point of separation of the two mouths of the Hingador.
105	Instr.	S. 50 36 W.	160		102		124	
Instr.	106	S. 82 5 W.	130		18		129	Creek from the left.
106	Instr.	N. 47 40 W.	105	71			78	
Instr.	107	S. 73 20 W.	190		55		182	
107	Instr.	S. 54 35 W.	85		50		69	
Instr.	108	S. 7 55 E.	100		99	14		
108	Instr.	S. 64 5 W.	100		44		90	
Instr.	109	N. 45 55 W.	125	87			90	
109	Instr.	S. 83 5 W.	60		8		60	
Instr.	110	S. 34 50 W.	210		173		120	
110	Instr.	S. 8 40 W.	400		398		60	
Instr.	111	S. 34 5 W.	380		316		213	
111	Instr.	S. 64 20 W.	185		81		167	
Instr.	112	S. 83 50 W.	195		21		194	
112	Instr.	S. 35 20 W.	160		131		93	
Instr.	113	S. 8 5 W.	310		308		44	
113	Instr.	S. 37 5 W.	130		104		79	
Instr.	114	N. 47 55 W.	190	128			141	
114	Instr.	N. 34 25 W.	140	116			79	Hot spring on right bank.
Instr.	115	S. 49 20 W.	150		98		114	
115	Instr.	S. 10 50 W.	180		178		32	Hot spring on left bank.
Instr.	116	S. 56 50 W.	110		61		92	
116	Instr.	N. 68 30 W.	440	164			410	
Instr.	117	S. 62 5 W.	220		104		195	
117	Instr.	S. 27 20 W.	180		161		83	
Instr.	118	S. 62 20 W.	120		56		106	
118	Instr.	S. 23 55 E.	280		256	115		
Instr.	119	S. 48 5 W.	185		124		138	
119	Instr.	S. 10 25 E.	150		148	27		Island.
Instr.	120	S. 47 25 E.	205		140	151		

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° '	*Feet.*					
120	Instr.	S. 14 40 E.	245		240	62		
Instr.	121	N. 77 10 W.	150	33			146	
121	Instr.	N. 73 25 W.	80	23			77	
Instr.	122	S. 2 25 E.	280		280	12		
122	Instr.	S. 81 35 W.	315		50		313	
Instr.	123	N. 50 25 W.	220	141			170	
123	Instr.	N. 46 10 W.	140	97			101	
Instr.	124	S. 65 20 W.	155		65		141	
124	Instr.	S. 11 5 W.	85		84		16	
Instr.	125	S. 51 25 E.	205		129	160		
125	Instr.	S 38 10 E.	215		173	133		
Instr.	126	S. 68 5 W.	115		43		107	
126	Instr.	N. 87 55 W.	165	6			165	
Instr.	127	N. 0 40 W.	130	130			2	
127	Instr.	N. 80 55 W.	240	38			237	
Instr.	128	S. 57 5 W.	170		93		143	
128	Instr.	S. 32 5 W.	130		111		69	
Instr.	129	S. 16 35 W.	110		106		31	
129	Instr.	S. 36 40 E.	115		92	69		Cataract, five feet high.
Instr.	130	S. 27 40 E.	120		107	56		
130	Instr.	S. 42 35 W.	170		126		115	
Instr.	131	S. 63 5 W.	125		57		111	
131	Instr.	N. 56 10 W.	150	84			125	
Instr.	132	N. 45 55 W.	105	73			75	
132	Instr.	N. 87 55 W.	185	7			185	
Instr.	133	N. 89 55 W.	95				95	
133	Instr.	S. 46 5 W.	200		140		144	
Instr.	134	S. 63 35 W.	190		85		190	
134	Instr.	N. 74 55 W.	120	31			116	
Instr.	135	N. 39 25 W.	200	155			127	
135	Instr.	N. 6 25 W.	155	155			17	
Instr.	136	N. 32 40 W.	200	169			108	
136	Instr.	N. 49 55 W.	135	87			103	
Instr.	137	N. 29 55 W.	160	139			80	Campo Sombroso.
137	Instr.	N. 6 25 W.	170	169			19	
Instr.	138	N. 26 20 E.	160	144		71		
138	Instr.	N. 3 45 W.	215	215			15	
Instr.	139	N. 28 55 W.	90	79			44	
139	Instr.	N. 39 10 W.	155	121			98	
Instr.	140	N. 88 10 W.	120	4			120	
140	Instr.	S. 78 5 W.	120		25		117	
Instr.	141	N. 64 40 W.	240	104			217	
141	Instr.	N. 56 10 W.	170	95			141	
Instr.	142	N. 75 25 W.	100	25			97	
142	Instr.	N. 76 55 W.	160	36			156	
Instr.	143	N. 24 55 W.	90	82			38	
143	Instr.	N. 4 40 W.	50	50			4	Foot of the Cataracts.
Instr.	144	S. 45 25 E.	10		7	7		
144	147	N. 34 40 W.	160	132			91	
147	148	N. 77 55 W.	80	17			78	
148	Instr.	S. 86 35 W.	40		3		40	
Instr.	149	S. 42 50 W.	8		6		5	
149	Instr.	S. 82 50 W.	20		3		20	
Instr.	150	S. 9 20 W.	25		25		4	
150	Instr.	S. 25 35 W.	45		41		19	
Instr.	151	S. 36 50 W.	80		64		48	Head of the Cataracts.
151	Instr.	S. 41 35 W.	231		174		154	
Instr.	152	N. 55 25 W.	150	85			124	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	*Feet.*					
152	Instr.	N. 22 40 W.	104	96			40	Campo del Salto. Tributary from the left.
Instr.	153	S. 89 20 W.	155		2		155	
153	Instr.	S. 70 35 W.	105		35		99	
Instr.	154	S. 24 5 W.	138		127		56	
154	Instr.	S. 60 35 W.	188		93		164	
Instr.	F. F.	N. 87 25 W.	67	....	....	....	....	Foot of the great Hingador Fall.
	155	N. 79 10 W.	267	51			263	Head of the great Hingador Fall.
155	Instr.	N. 81 40 W.	101	15			100	
Instr.	156	N. 2 10 W.	120	120			5	
156	Instr.	N. 75 50 W.	81	20			79	
Instr.	157	N. 54 10 W.	62	37			50	
157	Instr.	N. 10 25 W.	40	40			17	
Instr.	158	N. 75 25 W.	159	40			154	
158	Instr.	S. 86 50 W.	123		7		123	
Instr.	159	S. 27 5 W.	67		60		30	
159	Instr.	S. 84 5 W.	109		11		108	
Instr.	160	N. 15 10 W.	145	140			38	
160	Instr.	N. 58 10 W.	119	63			101	
Instr.	161	S. 81 50 W.	40		6		40	
161	Instr.	S. 24 5 W.	72		66		29	Tree-Crossing of the Hingador.
Instr.	162	S. 59 20 W.	45		23		39	
162	Instr.	S. 74 50 W.	66		17		64	
Instr.	163	S. 54 20 W.	70		41		57	
163	Instr.	S. 40 35 W.	82		62		53	
Instr.	164	S. 19 5 W.	69		65		22	
164	Instr.	S. 24 50 W.	74		67		31	
Instr.	165	S. 73 20 W.	77		22		74	
165	Instr.	S. 81 35 W.	51		8		51	
Instr.	166	S. 49 50 W.	63		41		48	
166	Instr.	S. 85 50 W.	78		6		78	
Instr.	167	N. 46 25 W.	75	52			54	
167	Instr.	N. 69 10 W.	196	70			183	
Instr.	168	S. 87 5 W.	93		5		93	
168	Instr.	N. 78 25 W.	120	24			117	
Instr.	169	S. 89 20 W.	119		1		119	
169	Instr.	S. 55 35 W.	93		53		77	
Instr.	170	S. 1 55 E.	114		114	4		
170	Instr.	S. 35 5 W.	120		72		96	Crossing the Hingador.
Instr.	171	S. 16 35 W.	130		125		37	
171	Instr.	S. 71 5 W.	123		40		116	
Instr.	172	S. 61 35 W.	35		17		31	
172	Instr.	S 28 50 W.	98		86		47	
Instr.	173	S. 86 20 W.	92		6		92	Crossing the Hingador.
173	Instr.	N. 88 25 W.	96	3			96	
Instr.	174	N. 72 55 W.	88	26			84	
174	Instr.	N. 41 0 W.	31	24			20	Crossing a branch of the Hingador.
Instr.	175	N. 81 40 W.	115	17			114	
175	Instr.	S 48 5 W.	114		76		85	
Instr.	176	S. 18 5 W.	92		88		29	Crossing a branch twice.
176	Instr.	S. 28 20 W.	242		214		115	
Instr.	177	S. 66 5 W.	110		45		101	
177	Instr.	S. 41 35 W.	115		86		76	
Instr.	178	S. 30 20 W.	114		99		58	Crossing a creek.
178	Instr.	S. 61 35 W.	136		65		120	
Instr.	179	S. 46 20 W.	89		62		64	Crossing a creek.
179	Instr.	S. 9 35 W.	103		102		17	Campo las Cabazeras del Hingador.
Instr.	180	S. 50 5 W.	86		55		66	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	*Feet.*					
180	Instr.	S. 75 5 W.	150		39		145	
Instr.	181	S. 69 50 W.	164		57		154	
181	Instr.	S. 51 35 W.	116		72		91	
Instr.	182	S. 63 50 W.	147		65		132	Crossing last branch of the Hingador, Rancho No. 4.
182	Instr.	S. 69 5 W.	140		50		131	
Instr.	183	N. 57 25 W.	151	82			127	
183	Instr.	N. 70 40 W.	52	17			49	
Instr.	184	N. 81 10 W.	125	19			124	
184	Instr.	N. 58 10 W.	105	56			89	
Instr.	185	N. 88 40 W.	137	3			137	
185	Instr.	N. 41 55 W.	134	100			90	
Instr.	186	N. 84 26 W.	82	8			81	
186	Instr.	N. 80 26 W.	214	36			211	
Instr.	187	S. 59 34 W.	45		23		39	
187	Instr.	N. 88 56 W.	67	2			67	
Instr.	188	S. 53 34 W.	144		86		116	
188	Instr.	S. 72 34 W.	82		25		78	
Instr.	189	S. 81 19 W.	130		20		128	
189	Instr.	S. 55 19 W.	200		114		165	
Instr.	190	S. 67 34 W.	162		62		150	
190	Instr.	S. 71 49 W.	158		50		150	
Instr.	191	S. 69 19 W.	146		52		137	
191	Instr.	S. 31 19 W.	96		82		50	
Instr.	192	S. 0 26 E.	107		107	1		
192	Instr.	S. 31 4 W	96		82		50	
Instr.	193	S. 49 34 W	107		70		82	
193	Instr.	S. 51 49 W.	131		81		103	
Instr.	194	S. 0 11 E.	54		54			
194	Instr.	S. 67 34 W.	79		30		73	
Instr.	195	S. 63 49 W.	114		51		102	
195	Instr.	S. 72 4 W.	109		34		104	
Instr.	196	S 50 49 W.	107		68		83	
196	Instr.	S. 43 4 W.	104		76		71	
Instr.	197	S. 27 4 W.	126		113		57	Principal divide of the waters of the Atlantic and Pacific.
197	Instr.	S. 65 34 W.	186		77		170	
Instr.	198	S. 60 49 W.	120		59		105	
198	Instr.	S. 26 4 W.	189		170		83	
Instr.	199	S. 0 41 E.	198		198	3		
199	Instr.	S. 7 34 W.	122		121		16	
Instr.	200	S. 61 4 W.	127		62		111	
200	Instr.	S. 50 49 W.	229		146		178	
Instr.	201	S. 37 19 W.	169		135		103	
201	Instr.	S. 5 4 W.	111		111		10	
Instr.	202	S. 38 19 W.	144		114		90	
202	Instr.	S. 52 34 W.	89		54		71	
Instr.	203	N. 75 41 W.	96	24			93	
203	Instr.	S. 78 4 W.	171		36		168	
Instr.	204	S. 49 49 W.	155		101		119	
204	Instr.	S. 36 4 W.	57		46		34	
Instr.	205	S. 44 34 W.	136		97		96	
205	Instr.	S. 28 34 W.	169		149		81	
Instr.	206	S. 37 34 W.	190		151		116	
206	Instr.	S. 43 19 W.	100		73		69	
Instr.	207	S. 30 34 W.	161		139		82	
207	Instr.	S. 66 49 W.	153		61		141	
Instr.	208	S. 87 4 W.	67		4		67	
208	Instr.	S. 81 34 W.	132		20		131	
Instr.	209	S. 57 34 W.	131		71		111	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	
		° ′	*Feet.*					
209	Instr.	S. 84 4 W.	63		7		62	
Instr.	210	S. 67 49 W.	178		68		165	
210	Instr.	S. 54 19 W.	129		76		105	
Instr.	211	S. 68 34 W.	218		80		203	
211	Instr.	S. 54 34 W.	106		62		86	
Instr.	212	S. 60 4 W.	83		42		72	
212	Instr.	S. 64 4 W.	228		101		205	
Instr.	213	S. 83 19 W.	137		16		136	
213	Instr.	N. 84 26 W.	133	13			132	
Instr.	214	S. 84 4 W.	207		22		206	
214	Instr.	S. 14 34 W.	65		63		16	
Instr.	215	S. 52 34 W.	201		123		160	Branch of Rio Chuperador, to the left.
215	Instr.	S. 4 49 W.	95		95		8	
Instr.	216	S. 39 26 E.	203		158	130		
216	Instr.	S. 65 56 E.	100		41	91		
Instr.	217	S. 75 11 E.	131		34	127		Camp Chuperador.
217	Instr.	S. 25 26 E.	86		78	37		
Instr.	218	S. 25 56 E.	122		110	53		
	C. R.	S. 25 56 E.	35	....	....	....	....	Rio Chuperador.
218	Instr.	S. 16 4 W.	95		92		26	
Instr.	219	S. 29 19 W.	189		166		93	
219	Instr.	S. 15 4 W.	104		101		27	
Instr.	220	S. 38 4 W.	132		105		81	
220	Instr.	S. 26 49 W.	167		150		75	
Instr.	221	S. 38 4 W.	139		110		86	
221	Instr.	S. 27 4 W.	80		71		36	
Instr.	222	S. 14 49 W.	109		106		30	
222	Instr.	S. 10 11 E.	109		107	19		
Instr.	223	S. 13 34 W.	108		105		35	
223	Instr.	S. 69 34 W.	100		35		94	
Instr.	224	S. 81 34 W.	80		12		79	
224	Instr.	S. 31 19 W.	114		98		59	
Instr.	225	S. 1 19 W.	116		116		3	
225	Instr.	S. 33 19 W.	121		102		67	
Instr.	226	S. 0 41 E.	103		103	2		
226	Instr.	S. 25 34 W.	149		135		65	
Instr.	227	S. 41 34 W.	225		169		150	
227	Instr.	S. 76 34 W.	108		25		105	
Instr.	228	N. 89 26 W.	158	2			158	
228	Instr.	S. 61 49 W.	228		108		201	
Instr.	229	S. 51 19 W.	82		52		64	
229	Instr.	N. 86 26 W.	129	8			129	
Instr.	230	N. 59 26 W.	220	113			190	
230	Instr.	S. 83 4 W.	142		17		141	
Instr.	231	S. 42 19 W.	209		156		141	
231	Instr.	S. 29 4 W.	87		76		42	
Instr.	232	S. 7 4 W.	104		104		13	
232	Instr.	S. 17 34 W.	118		113		36	
Instr.	Qu.	S. 7 4 W.	84	....	....	....	....	Quebrada Rancho, No. 3.
	233	S. 7 4 W.	132		131		16	Campo los Charcos.
233	Instr.	S. 32 34 W.	98		83		53	
Instr.	234	S. 15 19 W.	125		121		33	
234	Instr.	S. 26 34 W.	176		158		79	
Instr.	235	S. 29 49 W.	154		134		77	
235	Instr.	S. 37 4 W.	57		46		34	
Instr.	236	S. 0 41 E.	62		62	1		
236	Instr.	S. 8 19 W.	74		73		11	
Instr.	237	S. 34 4 W.	123		102		69	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	*Feet.*					
237	Instr.	S. 17 49 W.	92		89		28	
Instr.	238	S. 2 11 E.	123		123	5		
238	Instr.	S. 5 26 E.	88		88	8		
Instr.	239	S. 27 11 E.	101		90	46		
239	Instr.	S. 15 56 E.	95		92	26		
Instr.	240	S. 31 19 W.	113		97		59	
240	Instr.	S. 65 49 W.	128		53		117	
Instr.	241	S. 72 19 W.	121		37		115	On a log, 2 feet 2 inches high.
241	Instr.	S. 63 4 W.	72		33		64	
Instr.	242	N. 66 41 W.	143	57			131	
242	Instr.	N. 61 26 W.	91	44			80	
Instr.	243	N. 31 26 W.	125	107			65	
243	Instr.	N. 45 11 W.	113	80			80	
Instr.	244	N. 84 26 W.	229	23			228	
244	Instr.	S. 83 34 W.	174		20		173	
Instr.	245	N. 76 11 W.	108	26			105	
245	Instr.	N. 83 26 W.	143	17			142	
Instr.	246	N. 66 41 W.	109	43			100	
246	Instr.	N. 37 41 W.	133	106			81	
Instr.	247	N. 31 26 W.	144	123			75	
247	Instr.	N. 49 41 W.	155	101			119	
Instr.	248	N. 80 56 W.	146	23			144	
248	Instr.	S. 84 49 W.	94		9		94	
Instr.	249	N. 85 26 W.	165	13			164	
249	Instr.	S. 70 4 W.	81		28		76	
Instr.	250	S. 61 34 W.	120		57		106	
250	Instr.	N. 81 11 W.	118	18			117	
Instr.	251	N. 79 11 W.	109	21			107	
251	Instr.	N. 76 56 W.	79	18			77	
Instr.	252	N. 54 26 W.	113	66			92	
252	Instr.	N. 83 41 W.	147	16			146	
Instr.	253	N. 46 56 W.	82	56			60	
253	Instr.	N. 7 26 W.	62	62			8	
Instr.	254	N. 24 11 W.	162	148			67	
254	Instr.	N. 56 56 W.	132	72			111	
Instr.	255	N. 48 56 W.	82	54			62	
255	Instr.	N. 57 11 W.	127	69			107	
Instr.	256	N. 58 26 W.	113	59			96	
256	Instr.	N. 58 26 W.	90	47			77	
Instr.	257	S. 84 34 W.	137		13		136	
257	Instr.	N. 53 41 W.	93	55			75	
Instr.	258	N. 34 42 W.	98	81			56	
258	Instr.	N. 69 27 W.	76	27			71	
Instr.	259	S. 89 3 W.	96		2		96	
259	Instr.	S. 78 3 W.	146		31		143	
Instr.	260	S. 40 48 W.	98		75		64	
260	Instr.	S. 14 48 W.	115		112		30	
Instr.	261	S. 29 48 W.	131		114		65	
261	Instr.	S. 40 48 W.	117		89		76	
Instr.	262	S. 14 33 W.	57		55		14	
262	Instr.	S. 5 12 E.	87		87	8		
Instr.	263	S. 56 3 W.	117		66		97	
263	Instr.	S. 66 18 W.	111		45		102	
Instr.	264	N. 89 42 W.	119	1			119	
264	Instr.	N. 87 57 W.	126	5			126	
Instr.	265	S. 59 48 W.	120		61		104	
265	Instr.	S. 70 3 W.	147		50		138	
Instr.	266	S. 72 3 W.	160		50		152	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	*Feet.*					
266	Instr.	S. 51 48 W.	169		105		133	
Instr.	267	S. 22 33 W.	135		125		52	
267	Instr.	S. 22 33 W.	38		35		15	
Instr.	268	S. 73 33 W.	124		35		119	
268	Instr.	S. 82 33 W.	47		6		47	
Instr.	269	S. 66 3 W.	131		54		120	
269	Instr.	S. 36 18 W.	84		68		50	
Instr.	270	S. 61 18 W.	117		56		102	
270	Instr.	S. 78 48 W.	84		16		82	
Instr.	271	S. 84 33 W.	164		16		163	
271	Instr.	N. 42 42 W.	79	58			54	
Instr.	272	N. 48 57 W.	101	67			76	
272	Instr.	N. 75 27 W.	226	57			219	
Instr.	273	N. 65 57 W.	86	35			79	
273	Instr.	N. 68 12 W.	125	47			116	
Instr.	274	N. 75 27 W.	132	36			128	
274	Instr.	N. 87 57 W.	92	4			92	
Instr.	275	S. 89 33 W.	111		1		111	
275	Instr.	N. 59 57 W.	91	46			79	
Instr.	276	N. 80 27 W.	126	21			124	
276	Instr.	S. 81 18 W.	167		26		165	
Instr.	277	S. 73 18 W.	69		20		67	
277	Instr.	S. 83 3 W.	106		14		106	
Instr.	278	S. 58 33 W.	117		62		100	
278	Instr.	S. 78 48 W.	165		32		162	
Instr.	279	N. 80 12 W.	106	18			105	
279	Instr.	N. 70 48 W.	75		25		71	
Instr.	280	N. 84 27 W.	121	12			120	
280	Instr.	N. 80 57 W.	114	18			113	
Instr.	281	N. 44 12 W.	106	76			75	
281	Instr.	N. 49 57 W.	87	56			67	
Instr.	282	N. 48 27 W.	91	61			68	
282	Instr.	N. 48 27 W.	96	64			72	
Instr.	283	N. 78 57 W.	95	18			93	
283	Instr.	S. 76 3 W.	135		33		131	
Instr.	284	N. 89 57 W.	135	—	—		135	
284	Instr.	N. 74 12 W.	105	29			101	
Instr.	285	S. 86 48 W.	81		5		81	
285	Instr.	N. 63 12 W.	136	62			122	
Instr.	286	N. 1 48 E.	165	165		4		Creek to the right. Fork of trail.
286	Instr.	N. 44 27 W.	117	84			82	
Instr.	287	N. 81 12 W.	176	27			174	
287	Instr.	N. 21 42 W.	167	156			62	
Instr.	288	N. 66 57 W.	132	52			122	
288	Instr.	S. 62 18 W.	132		62		117	
Instr.	289	S. 86 3 W.	181		14		180	
289	Instr.	N. 77 27 W.	116	25			113	
Instr.	290	N. 78 42 W.	119	24			117	
290	Instr.	N. 73 57 W.	176	49			169	
Instr.	291	N. 14 27 W.	218	202			55	
291	Instr.	N. 22 57 W.	109	101			42	
Instr.	Ch. R.	N. 75 57 W.	85	....	....	....	....	Rio Chupepe, 30 feet wide, to the left. Campo Chupepe. Rancho No. 2.
	292	N. 75 57 W.	129	32			125	
292	Instr.	N. 60 42 W.	98	48			86	
Instr.	293	N. 71 42 W.	110	35			104	
293	Instr.	N. 57 12 W.	155	84			131	
Instr.	294	N. 85 27 W.	92	8			92	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	*Feet.*					
294	Instr.	N. 80 27 W.	145	24			143	Tributary of the Chupepe, 15 feet wide.
Instr.	295	N. 77 27 W.	164	36			160	
295	Instr.	S. 89 33 W.	128		1		128	
Instr.	296	N. 60 57 W.	196	96			172	
296	Instr.	N. 34 42 W.	143	118			81	
Instr.	297	N. 71 12 W.	236	76			224	
297	Instr.	N. 87 27 W.	150	7			150	
Instr.	298	N. 74 12 W.	85	23			82	
298	Instr.	N. 57 42 W.	205	110			174	
Instr.	299	N. 68 42 W.	217	79			202	
299	Instr.	N. 56 42 W.	192	106			161	
Instr.	300	N. 65 27 W.	115	48			105	
300	Instr.	N. 88 57 W.	157	3			157	
Instr.	301	S. 31 48 W.	100		85		53	Creek, 10 feet wide.
301	Instr.	S. 27 2 W.	102		91		46	
Instr.	302	S. 53 47 W.	88		52		71	
302	Instr.	S. 60 17 W.	152		76		132	
Instr.	303	S. 76 32 W.	133		31		129	
303	Instr.	S. 75 47 W.	131		33		127	
Instr.	304	N. 75 58 W.	130	32			126	
304	Instr.	S. 83 47 W.	231		25		230	
Instr.	305	N. 81 13 W.	144	22			142	
305	Instr.	S. 85 32 W.	111		9		111	
Instr.	306	S. 72 2 W.	127		39		121	
306	Instr.	S. 53 32 W.	141		84		113	
Instr.	307	S. 16 17 W.	122		118		34	
307	Instr.	S. 4 2 W.	95		95		7	
Instr.	308	S. 12 13 E.	115		113	24		
308	Instr.	S. 20 32 W.	74		69		26	
Instr.	309	S. 10 28 E.	118		116	21		
309	Instr.	S. 27 47 W.	179		159		84	
Instr.	310	S. 57 47 W.	138		74		117	
310	Instr.	S. 40 47 W.	99		75		65	
Instr.	311	S. 64 47 W.	101		43		92	
311	Instr.	S. 89 2 W.	170		3		170	
Instr.	312	S. 34 17 W.	119		99		67	
312	Instr.	S. 30 32 W.	139		120		71	
Instr.	313	S. 30 32 W.	117		101		60	
313	Instr.	S. 73 47 W.	132		37		127	
Instr.	314	S. 41 2 W.	134		102		88	
314	Instr.	S. 46 2 W.	195		136		141	
Instr.	315	S. 75 2 W.	111		29		107	
315	Instr.	S. 77 47 W.	127		27		124	
Instr.	316	N. 80 43 W.	112	18			110	
316	Instr.	S. 86 17 W.	147		10		147	
Instr.	317	S. 83 47 W.	103		12		102	
317	Instr.	N. 27 58 W.	144	128			68	
Instr.	318	N. 11 58 W.	91	89			19	
318	Instr.	N. 7 13 W.	173	172			22	
Instr.	319	N. 13 43 W.	69	67			16	
319	Instr.	N. 46 13 W.	138	96			100	
Instr.	320	N. 41 28 W.	128	96			85	
320	Instr.	N. 28 13 W.	164	145			78	
Instr.	321	N. 14 13 W.	88	86			22	
321	Instr.	N. 8 32 E.	62	62		9		
Instr.	322	N. 9 28 W.	93	92			15	
322	Instr.	N. 46 13 W.	191	133			138	
Instr.	323	N. 13 58 W.	79	77			19	

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° '	*Feet.*					
323	Instr.	N. 2 43 W.	156	156			8	
Instr.	324	N. 45 58 W.	67	47			48	
324	Instr.	N. 43 28 W.	129	94			89	
Instr.	325	N. 29 43 W.	114	99			56	
325	Instr.	N. 29 58 W.	114	99			57	
Instr.	326	N. 66 58 W.	86	34			79	
326	Instr.	N. 89 58 W.	149	—	—		149	
Instr.	327	S. 74 32 W.	142		38		137	
327	Instr.	S. 82 32 W.	254		33		252	
Instr.	328	S. 79 32 W.	108		20		106	
328	Instr.	S. 82 17 W.	160		22		158	
Instr.	329	S. 77 2 W.	126		28		123	
329	Instr.	S. 61 32 W.	98		47		86	
Instr.	330	S. 88 17 W.	105		3		105	
330	Instr.	S. 54 17 W.	99		58		80	
Instr.	331	S. 65 32 W.	136		56		124	Cascade heard on the right.
331	Instr.	S. 81 32 W.	136		20		134	Very narrow crest.
Instr.	332	S. 78 2 W.	83		17		81	
332	Instr.	S. 86 2 W.	33		2		33	
Instr.	333	S. 72 2 W.	134		42		127	
333	Instr.	S. 65 2 W.	136		58		123	Rio Pie de Nercua.
Instr.	334	S. 76 2 W.	96		23		93	
334	Instr.	S. 15 58 E.	70		67	19		
Instr.	335	S. 63 2 W.	190		87		169	Dos Bocas, confluence of
335	Instr.	S. 51 17 W.	60		38		47	the Pie de Nercua, with
Instr.	336	S. 10 1 W.	125		123		22	a stream from the right.
336	Instr.	N. 79 59 W.	85	15			84	
Instr.	337	N. 44 29 W.	100	71			70	
337	Instr.	S. 54 1 W.	105		62		85	
Instr.	338	N. 50 59 W.	105	66			82	
338	Instr.	N. 30 44 W.	120	103			61	
Instr.	339	S. 51 1 W.	125		79		97	Barometrical station.
339	Instr.	S. 38 31 W.	175		138		109	
Instr.	340	N. 75 29 W.	100	25			97	
340	Instr.	N. 25 14 W.	185	168			79	
Instr.	341	N. 0 1 E.	130	130		—	—	
341	Instr.	N. 77 14 W.	245	55			239	
Instr.	342	S. 89 1 W.	105		2		105	
342	Instr.	N. 26 31 E.	160	144		72		
Instr.	343	N. 37 31 E.	240	191		146		
343	Instr.	N. 27 29 W.	85	76			39	
Instr.	344	N. 86 29 W.	180	11			180	
344	Instr.	S. 75 31 W.	245		62		238	
Instr.	345	N. 31 14 W.	110	94			57	
345	Instr.	N. 19 46 E.	145	137		49		
Instr.	346	N. 34 1 E.	250	208		140		
346	Instr.	N. 38 59 W.	160	125			101	
Instr.	347	S. 80 16 W.	220		38		217	
347	Instr.	S. 11 46 W.	355		350		72	
Instr.	348	S. 86 16 W.	75		5		75	
348	Instr.	N. 44 44 W.	335	240			238	
Instr.	349	N. 64 44 W.	155	67			140	
349	Instr.	S. 76 31 W.	340		81		330	
Instr.	350	N. 81 59 W.	200	28			198	
350	Instr.	S. 4 29 E.	120		120	9		
Instr.	351	S. 43 29 E.	260		189	180		Campo Pie de Nercua. Rancho No. 1.

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	*Feet.*					
351	Instr.	S. 39 1 W.	105		82		66	Upper mouth of Rio Totumia.
Instr.	352	N. 56 59 W.	280	154			235	
352	Instr.	N. 74 59 W.	60	16			58	Confluence of Pie de Nercua and Rio Totumia, each 50 feet wide.
Instr.	353	N. 50 31 W.	230	147			178	Rio Totumia after junction 80 feet wide.
353	Instr.	S. 38 31 W.	450		359		275	
Instr.	354	S. 1 31 W.	335		335		9	
354	Instr.	S. 29 14 E.	330		290	161		
Instr.	355	S. 74 44 E.	230		61	222		
355	Instr.	S. 31 44 E.	290		249	153		
Instr.	356	S. 44 31 W.	520		374		368	
356	Instr.	S. 15 46 W.	1020		985		279	
Instr.	357	S. 89 31 W.	205		2		205	
357	Instr.	N. 74 59 W.	185	48			179	
Instr.	358	N. 86 14 W,	230	16			229	
358	Instr.	S. 67 16 W.	290		113		268	
Instr.	359	S. 0 46 W.	290		290		4	
359	Instr.	S. 17 59 E.	290		278	90		
Instr.	360	S. 37 29 E.	520		415	319		
360	Instr.	S. 29 16 W.	250		219		122	Rancho of the Alcalde of Paracuchichi.
Instr.	361	S. 52 1 W.	460		285		364	Last hill on the left.
361	Instr.	S. 79 1 W.	180		35		177	
Instr.	362	S. 64 46 W.	390		168		352	
362	Instr.	N. 45 0 W.	160	114			114	
Instr.	363	N. 78 29 W.	210	42			206	
363	Instr.	N. 22 29 W.	300	280			116	
Instr.	364	N. 66 44 W.	370	150			340	
364	Instr.	N. 84 59 W.	90	8			90	
Instr.	365	S. 43 16 W.	250		183		172	
365	Instr.	S. 5 1 W.	290		290		25	
Instr.	366	S. 19 1 W.	240		227		79	
366	Instr.	S. 40 1 W.	295		230		186	
Instr.	367	S. 27 14 E.	105		94	48		
367	Instr.	N. 59 1 E.	270	140		232		
Instr.	368	N. 57 46 E.	270	145		229		
368	Instr.	S. 71 59 E.	40		13	38		
Instr.	369	S. 56 29 E.	110		61	92		
369	Instr.	S. 15 29 E.	185		179	39		
Instr.	370	S. 30 1 W.	325		285		162	
370	Instr.	S. 11 31 W.	500		493		100	
Instr.	371	S. 78 1 W.	160		34		156	
371	Instr.	N. 54 14 W.	250	147			203	
Instr.	372	N. 63 59 W.	145	64			130	Domingo's rancho.
372	Instr.	S. 84 1 W.	130		14		129	
Instr.	173	S. 23 16 W.	330		305		131	
373	Instr.	S. 53 31 W.	595		355		480	Last tide mark.
Instr.	374	S. 11 59 E.	170		167	35		
374	Instr.	S. 17 1 W.	130		125		38	Commencement of the mangrove region.
Instr.	375	S. 46 46 W.	275		190		200	
375	Instr.	S. 17 44 E.	230		121	72		
Instr.	376	S. 69 26 W.	180		64		169	
376	Instr.	N. 78 59 W.	235	45			231	
Instr.	377	S. 41 1 W.	235		178		155	
377	Instr.	S. 33 44 E.	200		167	111		
Instr.	378	S. 36 20 E.	425		346	255		
378	Instr.	S. 40 59 E.	295		225	195		

TABLE No. I—Continued.

From station.	To station.	True course.	Distance.	Latitude. North.	Latitude. South.	Departure. East.	Departure. West.	Remarks.
		° ′	*Feet.*					
Instr.	379	S. 10 31 W.	295		292		55	
379	Instr.	S. 68 46 W.	670		245		625	
Instr.	380	S. 3 1 W.	250		250		14	
380	Instr.	S. 37 59 E.	490		388	302		
Instr.	381	S. 0 44 E.	250		250	3		
381	Instr.	S. 28 14 E.	590		522	280		
Instr.	382	S. 58 31 W.	920		483		785	Mouth of Rio Totumia.
382	Instr.	S. 39 46 W.	1295		998		830	Sand bar, dry at low water.
Instr.	383	S. 28 16 W.	950		840		.452	Bahia Ensenada, called Kelley's Inlet.
383	1	S. 1 37 E.	635		635	19		Isla de la Playa.
1	*b*	N. 76 45 W.	1520	352			1480	
b	*a*	N. 76 45 W.	1100	255			1070	
a	0	N. 76 45 W.	500	126			488	
0	A.St.	N. 25 30 W.	440	400			190	Astronomical station, Campo la Playa.

TABLE No. II.

HEIGHTS AND DISTANCES, BY MEASUREMENT WITH ENGINEER'S LEVEL AND THEODOLITE.

COMPUTED BY JOHN DE LA CAMP.

[Sea level: Mean tide of the Pacific, considered on the same level with the mean tide of the Atlantic.]

From station.	To station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	*Feet.*	*Feet.*	
	A. R.			25.73	....	....	Surface of Atrato river on February 23, 1858.
A. R.	169	11.50		37.23	....	....	Highest point of shore at Sucio village.
169	B. St.			36.54	125	125	Barometrical station at Sucio.
	170		7.73	29.50	2505	2,505	Salaqui mouth of Truandó river.
170	171		2.81	26.69	3540	6,045	Instrumental station, at the mouth of Sucio river.
171	172	—	—	26.69	3010	9,055	171 and 172 at surface of Atrato river.
172	173	2.29		28.98	2805	11,860	Opposite Boca Caimanero of Truandó river.
173	174		0.54	28.44	1995	13,855	
174	175		0.10	28.34	2095	15,950	
175	176	1.60		29.94	1560	17,510	
176	177	1.00		30.94	1450	18,960	
177	178	0.40		31.34	1520	20,480	
178	179		1.73	29.61	1630	22,110	
179	180		2.03	27.58	985	23,095	
180	181	1.83		29.41	1680	24,775	
181	182		1.40	28.01	2215	26,990	
182	183		1.55	26.46	1085	28,075	Near separation of Salaqui channel.
183	184	1.85		28.31	1330	29,405	
184	185	0.89		29.20	1795	31,200	
185	186		0.05	29.15	1270	32,470	
186	187		1.07	28.08	1615	34,085	
187	188		0.26	27.82	1465	35,550	
188	189	0.10		27.92	1085	36,635	
189	190	0.63		28.55	1310	37,945	
190	191		0.05	28.50	1230	39,175	
191	192		1.00	27.50	905	40,080	
192	193		0.84	26.66	1685	41,765	
193	194	1.15		27.81	1230	42,995	
194	195		1.02	26.79	1385	44,380	
195	196	2.99		29.78	2115	46,495	
196	197	1.02		30.80	1220	47,715	
197	198		1.28	29.52	1695	49,410	
198	199		0.20	29.32	1595	51,005	Campo Abertura.
199	200		0.07	29.25	1780	52,785	
200	201	0.64		29.89	1550	54,335	
201	202		0.92	28.97	1910	56,245	
202	203		0.18	28.79	1690	57,935	
203	204		1.15	27.64	2130	60,065	Fishing rancho on the left.
204	205	1.16		28.80	1360	61,425	

TABLE No. II—Continued.

From station.	To station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	*Feet.*	*Feet.*	
205	206		1.30	27.50	1710	63,135	
206	207	0.45		27.95	1740	64,875	Fishing rancho on the left.
207	208	0.58		28.53	2160	67,035	
208	209	0.41		28.94	1775	68,810	
209	210		1.08	27.86	1380	70,190	
210	211	0.60		28.46	2110	72,300	
211	212	0.06		28.52	1940	74,240	
212	213		0.27	28.25	1880	76,120	
213	214		0.49	27.76	1220	77,340	
214	215		0.33	27.43	1080	78,420	
215	216	1.04		28.47	1185	79,605	
216	217		0.47	28.00	2205	81,810	
217	218	1.13		29.13	1340	83,150	
218	219		1.00	28.13	810	83,960	
219	220	0.29		28.42	1920	85,880	
220	221	0.84		29.26	1430	87,310	
221	222	1.67		30.93	1055	88,365	
222	223		1.24	29.69	1970	90,335	Near rancho La Clarita.
223	224		1.16	28.53	935	91,270	
224	225		0.01	28.52	1090	92,360	Campo Clarita.
225	226	0.75		29.27	785	93,145	
226	227	1.85		31.12	745	93,890	
227	228		1.59	29.53	775	94,665	
228	229	1.73		31.26	720	95,385	
229	230		1.54	29.72	1015	96,400	
230	231		0.30	29.42	1655	98,055	
231	232		0.96	28.46	685	98,740	
232	233		0.96	27.50	1595	100,335	
233	234	2.04		29.54	1650	101,985	
234	235	0.38		29.92	1305	103,290	
235	236		0.74	29.18	1645	104,935	
236	237		0.40	28.78	1025	105,960	
237	238	0.58		29.36	2190	108,150	
238	239	3.52		32.88	3465	111,615	
239	240	0.44		33.32	3280	114,895	
240	241	0.90		34.22	2740	117,635	
241	242		5.80	28.42	1295	118,930	
242	243	1.00		29.42	1525	120,455	
243	244		0.45	28.97	2695	123,150	Campo Quita Palos.
244	245		0.45	28.52	1710	124,860	Foot of the Palizadas.
245	246		0.91	27.61	1590	126,450	
246	247	1.23		28.84	710	127,160	
247	248		0.86	27.98	635	127,795	
248	249	1.54		29.52	860	128,655	
249	250	0.96		30.48	605	129,260	
250	251	1.70		32.18	690	129,950	
251	252		0.99	31.19	925	130,875	Punta Buenaventura.
252	253		0.40	30.79	915	131,790	
253	254	0.59		31.38	610	132,400	
254	255		0.16	31.22	705	133,105	
255	256		0.13	31.09	575	133,680	
256	257	0.40		31.49	1240	134,920	
257	258	0.73		32.22	1485	136,405	
258	259		0.70	31.52	615	137,020	
259	260	1.49		33.01	1095	138,115	
260	261		0.64	32.37	625	138,740	
261	262		0.38	31.99	625	139,365	
262	263	1.31		33.30	410	139,775	Campo las Isletas.
263	264		1.06	32.24	970	140,745	
264	265		0.21	32.03	605	141,350	
265	266		0.99	31.04	1005	142,355	

TABLE No. II—Continued.

To station.	From station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	*Feet.*	*Feet.*	
266	267		0.55	30.49	705	143,060	
267	268	0.47		30.96	890	143,950	
268	269		0.08	30.88	595	144,545	
269	270	0.56		31.44	1250	145,795	
270	271		0.42	31.02	900	146,695	
271	272	0.63		31.65	500	147,195	
272	273	0.78		32.43	820	148,015	
273	274		0.51	31.92	655	148,670	
274	275	0.70		32.62	725	149,395	
275	276	0.25		32.87	735	150,130	
276	277	1.40		34.27	745	150,875	
277	278		2.65	31.62	750	151,625	
278	279	1.13		32.75	335	151,960	
279	280		0.61	32.14	1050	153,010	
280	281		0.32	31.82	1725	154,735	
281	282	8.28		40.10	665	155,400	Rising to the top of the bank.
282	283		0.97	39.13	930	156,330	Campo Resumpcion.
283	284	0.50		39.63	740	157,070	
284	285		0.30	39.33	740	157,810	
285	286	0.83		40.16	650	158,460	
286	287		0.06	40.10	755	159,215	
287	288	0.43		40.53	730	159,945	
288	289		0.15	40.38	570	160,515	
289	290	0.40		40.78	760	161,275	
290	291	0.47		41.25	785	162,060	
291	292	0.19		41.44	905	162,965	
292	293	0.39		41.83	445	163,410	
293	294	0.43		42.26	840	164,250	
294	295		0.32	41.94	750	165,000	
295	296	1.04		42.98	400	165,400	
296	297	0.30		43.28	625	166,025	
297	298	0.54		43.82	685	166,710	
298	299	0.63		44.45	555	167,365	
299	300		0.23	44.22	170	167,535	Campo las Palizadas on left shore, in front of Lieut. Michler's tent. Called First Camp in report.
	301	0.12		44.57	300	167,665	
301	302	0.74		45.31	260	167,925	
	B. St.		0.26	44.31	150	168,075	Barometrical station.
302	303	0.57		45.88	475	168,400	
303	304	0.28		46.16	395	168,795	
304	305		0.27	45.89	510	169,205	
305	306	0.40		46.29	350	169,555	
306	307	0.35		46.64	260	169,815	
307	308	0.53		47.17	300	170,115	
308	309	0.44		47.61	580	170,695	
309	310	0.30		47.91	315	171,010	
310	311	0.52		48.43	700	171,710	
311	312	0.43		48.86	255	171,965	
312	313	0.06		48.92	460	172,425	
313	314	1.03		49.95	365	172,790	
314	315	1.19		51.14	815	173,605	
315	316	0.82		51.96	750	174,355	
316	317	0.37		52.33	425	174,780	
317	318	0.40		52.73	350	175,130	
318	319	0.37		53.10	405	175,535	
319	320	0.56		53.66	580	176,115	
320	321	0.80		54.46	925	177,040	
321	322		0.94	53.52	420	177,460	
322	323	1.01		54.53	910	178,370	
323	324		2.72	51.81	750	179,120	
324	325	3.99		55.80	395	179,515	

TABLE No. II—Continued.

From station.	To station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	*Feet.*	*Feet.*	
325	326		0.22	55.58	760	180,275	
326	327		0.06	55.52	470	180,745	
327	328	0.55		56.07	665	181,410	
328	329	0.08		56.15	1085	182,495	
329	330		0.70	55.45	385	182,880	Camp; Rancho de Jose Maria Tocame.
330	331	3.77		59.22	545	183,425	
331	332		1.83	57.39	495	183,920	
332	333	0.83		58.22	790	184,710	
333	334		0.59	57.63	580	185,290	
334	335	1.00		58.63	315	185,605	
335	336	0.74		59.37	450	186,055	
336	337	1.07		60.44	855	186,910	
337	338	1.24		61.68	540	187,450	
338	339	0.62		62.30	530	187,980	
339	340	0.12		62.42	575	188,555	
340	341	0.57		62.99	770	189,325	
341	342		0.02	62.97	675	190,000	
342	343		0.78	62.19	605	190,605	
343	344	1.86		64.05	695	191,300	
344	345	0.15		64.20	870	192,170	
345	346		7.32	56.88	900	193,070	In the bed of the river.
346	347		0.03	56.85	380	193,450	
347	348	1.03		57.88	605	194,055	
348	349		0.56	57.32	695	194,750	
349	350	1.88		59.20	1015	195,765	
350	351	2.48		61.68	555	196,320	
351	352		1.28	60.40	560	196,880	
352	353	4.16		64.56	555	197,435	On Great Palisade.
353	354		2.75	61.81	380	197,815	
354	355	1.67		63.48	395	198,210	
355	356	0.37		63.85	555	198,765	
356	357	0.91		64.76	595	199,360	
357	358	3.54		68.30	770	200,130	On Great Palisade.
358	359		1.23	67.07	1480	201,610	Head of the Palizadas.
359	360	0.14		67.21	1115	202,725	
360	361		0.64	66.57	1335	204,060	
361	362	1.38		67.95	1240	205,300	
362	363	2.08		70.03	1510	206,810	
363	364		1.66	68.37	2215	209,025	
364	365		1.15	67.12	1015	210,040	
365	366	3.09		70.31	1550	211,590	
366	367	0.94		71.25	1950	213,540	
367	368		1.41	69.84	1040	214,580	
368	369		0.82	69.02	1650	216,230	
369	370	1.23		70.25	2140	218,370	
370	371		0.35	69.90	1490	219,860	
371	372		1.12	68.78	2560	222,420	
372	373	0.34		69.12	1640	224,060	
373	374	2.18		71.30	1845	225,905	
374	375	0.51		71.81	1205	227,110	Opposite Campo de Caiman.
375	376		1.25	70.56	1650	228,760	
376	377	0.79		71.35	2150	230,910	
377	378	1.98		73.33	1305	232.215	
378	379		0.88	72.45	750	232,965	
379	380		0.08	72.37	2000	234,965	
380	381	0.23		72.60	1690	236,655	
381	362	1.01		73.61	1800	238,455	
382	383	3.15		76.76	2835	241,290	
383	384		2.14	74.62	1385	242,675	
384	385	0.48		75.10	970	243,645	
385	386	1.45		76.55	1565	245,210	

TABLE No. II—Continued.

From station.	To station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	*Feet.*	*Feet.*	
386	387	2.19		78.74	2295	247,505	Near mouth of Rio Salado.
387	388		0.94	77.80	1605	249,110	First white sedimental clay
388	389	0.07		77.87	1000	250,110	rock.
389	390		0.34	77.53	1720	251,830	
390	391	0.89		78.42	1110	252,940	
391	392	1.08		79.50	995	253,935	
392	393	0.15		79.65	2220	256,155	
393	394		0.74	78.91	2540	258,695	
394	395	0.37		79.28	2435	261,130	
395	396		0.30	78.98	1240	262,370	
396	397	1.54		80.52	2000	264,370	First brown sedimental rock.
397	398	0.06		80.58	1585	265,955	
398	399	2.88		83.46	2435	268,390	
399	400		0.21	83.25	1480	269,870	
400	401	0.78		84.03	1230	271,100	
401	402		1.30	82.73	1680	272,780	
402	403	3.32		86.05	1695	274,475	Foot of the rapids.
403	404	0.30		86.35	1145	275,620	First metamorphic rock.
404	405	1.40		87.75	1875	277,495	Quebrada Peña baja.(Creek.)
405	406	3.54		91.29	1720	279,215	
406	407	1.91		93.20	585	279,800	
407	408	4.30		97.50	345	280,145	Campo Pie de los Saltos.
408	409	1.94		99.44	350	280,495	
409	O.H.	105.51		204.95	535	281,030	Astronomical and barometri-
	1	1.94		101.38	395	280,890	cal station, on Observatory
1	2	4.00		105.38	860	281,750	Hill.
2	3	4.59		109.97	490	282,240	Rio Escalero or Rio Calderon
3	4	9.34		119.31	820	283,060	from the left.
4	5	9.17		128.48	500	283,560	On large cataract.
5	6	10.31		138.79	640	284,200	
6	7	3.28		142.07	1190	285,390	Rancho at the rejunction of
7	8	6.34		148.41	570	285,960	trail and river. Campo de
8	9	1.59		150.00	985	286,945	los Saltos.
9	10	8.65		158.65	1340	288,285	
10	11	6.42		165.07	1190	289,475	
11	12	10.34		175.41	1850	291,325	Opposite Campo El Puerto del Truandó, at mouth of Quebrada Peña alta. (Creek.)
12	13	8.06		183.47	1095	292,420	Large boulders of quartz.
13	14	1.26		184.73	1200	293,620	
14	15	0.46		185.19	1385	295,005	Recommencement of alluvial
15	16		0.28	184.91	2000	297,005	banks.
16	17	1.03		185.94	990	297,995	
17	18	1.29		187.23	1390	299,385	Head of Truandó Falls.
18	19	1.20		188.43	1125	300,510	Rocky Island. Rapids. Dry
19	20	0.31		188.74	1800	302,310	branch on the left.
20	21		1.04	187.70	1525	303,835	
21	22	0.09		187.79	1900	305,735	
22	23	0.77		188.56	1640	307,375	
23	24		0.88	187.68	2025	309,400	
24	25	0.88		188.56	1510	310,910	
25	26	1.40		189.96	1395	312,305	Playa de la Wunga.
26	27	0.94		190.90	2090	314,395	
27	28		0.40	190.50	2475	316,870	
28	29	1.56		192.06	1130	318,000	Opposite camp, at mouth of
29	30	0.57		192.63	1340	319,340	Rio Nercua. Tambo de
30	31	1.57		194.20	1240	320,580	José.
31	32	0.85		195.05	1145	321,725	
32	33	0.46		195.51	1015	322,740	
33	34		1.42	194.09	855	323,595	
34	35	1.17		195.26	790	324,385	

TABLE No. II—Continued.

From station.	To station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	*Feet.*	*Feet.*	
35	36	1.14		196.40	775	325,160	
36	37	0.49		196.89	1410	326,570	
37	38		0.01	196.88	1180	327,750	
38	39	0.11		196.99	490	328,240	
39	40	1.90		198.89	825	329,065	
40	41	1.12		200.01	695	329,760	Mouth of Rio Grundó (Oodor) from the right.
41	42		0.59	199.42	1140	330,900	
42	43	0.11		199.53	860	331,760	
43	44	0.95		200.48	730	332,490	
44	45		0.92	199.56	795	333,285	Great palisade.
45	46	0.55		200.11	495	333,780	
46	47		0.13	199.98	755	334,535	
47	48	1.66		201.64	635	335,170	
48	49	0.61		202.25	565	335,735	
49	50		0.39	201.86	920	336,655	
50	51	2.30		204.16	875	337,530	
51	52	0.36		204.52	980	338,510	
52	53		1.23	203.29	960	339,470	
53	54	1.49		204.78	745	340,215	
54	55	0.82		205.60	985	341,200	Campo Agua Caliente.
55	56	1.05		206.65	855	342,055	
56	57	1.42		208.07	785	342,840	Hot sulphur spring on right bank.
57	58		0.99	207.08	645	343,485	
58	59	0.09		207.17	930	344,415	
59	60	2.52		209.69	675	345,090	
60	61	3.57		213.26	1215	346,305	
61	62		1.77	211.49	1115	347,420	
62	63		0.08	211.41	1625	349,045	
63	64		0.20	211.21	575	349,620	Mouth of Rio Equebrador, from the right.
64	65	0.96		212.17	1195	350,815	Small rancho on right bank.
65	66	1.27		213.44	640	351,455	
66	67		0.32	213.12	960	352,415	Rancho on left bank.
67	68	0.89		214.01	550	352,965	
68	69	0.30		214.31	730	353,695	
69	70	0.94		215.25	1000	354,695	
70	71	2.78		218.03	1010	355,705	Tributary from the left, 20 ft. wide. Rancho on left bank.
71	72		1.17	216.86	490	356,195	
72	73	1.27		218.13	1070	357,265	
73	74	0.86		218.99	625	357,890	
74	75	0.07		219.06	1215	359,105	
75	76	3.22		222.28	800	359,905	Island; main channel on the left.
76	77		1.61	220.67	930	360,835	Tributary from the right.
77	78	0.96		221.63	1295	362,130	Island; main channel on the left.
78	79	0.33		221.96	985	363,115	
79	80	3.35		225.31	1130	364,245	
80	81		0.39	224.92	880	365,125	Campo Playa Bonita.
81	82	2.16		227.08	800	365,925	
82	83		2.01	225.07	740	366,665	
83	84	2.36		227.43	1680	368,345	
84	85	1.62		229.05	530	368,875	Tributary from the left.
85	86		0.09	228.96	1100	369,975	
86	87	0.75		229.71	685	370,660	
87	88		0.60	229.11	600	371,260	
88	89	0.73		229.84	720	371,980	
89	90		0.39	229.45	1210	373,190	
90	91	4.52		233.97	750	373,940	Rio Pavarador from the right, 40 feet wide.
91	92		1.88	232.09	1090	375,030	
92	93	3.44		235.53	1880	376,910	
93	94	2.69		238.22	1385	378,295	

TABLE No. II—Continued.

From station.	To station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	*Feet.*	*Feet.*	
94	95	2.00		240.22	1075	379,370	
95	96	3.11		243.33	1725	381,095	
96	97	1.45		244.78	1220	382,315	First hill in sight.
97	98	2.44		247.22	895	383,210	
98	99	0.89		248.11	1050	384,260	
99	100	2.37		250.48	1345	385,605	
100	101	1.26		251.74	1035	386,640	
101	102	2.36		254.10	1020	387,660	
102	103	1.68		255.78	1395	389,055	Opposite lower mouth of Ri Hingador. Camp.
103	104	0.99		256.77	565	389,620	At upper mouth of Rio Hi gador. Camp.
104	105	4.42		261.19	385	390,005	Point of separation of the tw mouths of Rio Hingador.
	105*a*	1.76		258.53	940	390,560	
105*a*	106*a*	3.39		261.92	1145	391,705	Opposite Tambo de Antoni opposite commencement Indian trail.
106*a*	B. St.	2.48		264.40	165	391,870	Barometrical station.
105	106	0.44		261.63	290	390,295	Creek from the left.
106	107	4.91		266.54	295	390,590	
107	108	2.22		268.76	185	390,775	
108	109		0.44	268.32	225	391,000	
109	110	2.25		270.57	270	391,270	
110	111	9.29		279.86	780	392,050	
111	112	3.94		283.80	380	392,430	
112	113	7.16		290.96	470	392,900	
113	114	4.65		295.61	320	393,220	
114	115	5.75		301.36	290	393,510	Hot spring on right bank.
115	116	6.15		307.51	290	393,800	Hot spring on left bank.
116	117	9.06		316.57	660	394,460	
117	118	4.35		320.92	300	394,760	
118	119	7.44		328.36	465	395,225	
119	120	5.94		334.30	355	395,580	Island.
120	121	7.35		341.65	395	395,975	
121	122	5.76		347.41	360	396,335	
122	123	9.10		356.51	535	396,870	
123	124	6.67		363.18	295	397,165	
124	125	4.58		367.76	290	397,455	
125	126	7.50		375.26	330	397,785	
126	127	7.16		382.42	295	398,080	
127	128	10.51		392.93	410	398,490	
128	129	8.13		401.06	240	398,730	
129	130	9.70		410.76	235	398,965	Cataract, 5 feet high.
130	131	6.80		417.56	295	399,260	
131	132	6.51		424.07	255	399,515	
132	133	8.93		433.00	280	399,795	
133	134	8.85		441.85	390	400,185	
134	135	8.09		449.94	320	400,505	
135	136	6.34		456.28	355	400,860	
136	137	5.83		462.11	295	401,155	Campo Sombroso.
137	138	5.13		467.24	330	401,485	
138	139	10.09		477.33	305	401,790	
139	140	4.57		481.90	275	402,065	
140	141	11.31		493.21	360	402,425	
141	142	10.07		503.28	270	402,695	
142	143	13.12		516.40	250	402,945	
143	144	8.75		525.15	60	403,005	Foot of the Cataracts of R Hingador.
144	145	11.55		536.70	35	403,040	
145	146	6.20		542.90	0	403,040	
146	147	11.75		554.65	125	403,165	
147	148	12.21		566.86	80	403,245	

TABLE No. II—Continued.

From station.	To station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	*Feet.*	*Feet.*	
148	149	12.34		579.20	48	403,293	
149	150	12.84		592.04	45	403,338	Top of the Cataracts of Rio Hingador.
150	151	9.47		601.51	125	403,463	
151	Instr.	11.319		612.829	231	403,694	
Instr.	152	1.593		614.422	150	403,844	
152	Instr.	4.854		619.276	104	403,948	Campo del Salto. Tributary from the left.
Instr.	153	9.890		629.166	155	404,103	
153	Instr.	4.168		633.334	105	404,208	
Instr.	154	5.235		638.569	138	404,346	
154	Instr.	10.495		649.064	188	404,534	
Instr.	F. F.	7.527		656.591	67	404,601	Foot of the Great Hingador Fall.
	155	136.974		786.038	267	404,801	Top of the Great Hingador Fall.
155	Instr.	2.849		788.887	101	404,902	
Instr.	156		3.665	785.222	121	405,023	
156	Instr.		0.801	784.421	81	405,104	
Instr.	157	8.586		793.007	62	405,166	On a large log, about 4 feet high.
157	Instr.		3.144	789.863	40	405,206	
Instr.	158		1.781	788.082	159	405,365	
158	Instr.	3.130		791.212	123	405,488	
Instr.	159		0.487	790.725	67	405,555	
159	Instr.	2.552		793.277	109	405,664	
Instr.	160		1.793	791.484	145	405,809	
160	Instr.	2.665		794.149	119	405,928	
Instr.	161		0.303	793.846	40	405,968	
161	Instr.		2.617	791.229	72	406,040	Tree-crossing of the Hingador.
Instr.	162	20.741		811.970	45	406,085	
162	Instr.	14.718		826.688	66	406,151	
Instr.	163	9.728		836.416	70	406,221	
163	Instr.	4.208		840.624	82	406,303	
Instr.	164	7.891		848.515	69	406,372	
164	Instr.	8.345		856.860	74	406,446	
Instr.	165		3.135	853.725	77	406,523	
165	Instr.		12.910	840.815	51	406,574	
Instr.	166		13.325	827.490	63	406,637	
166	Instr.		5.871	821.619	78	406,715	
Instr.	167		7.361	814.258	75	406,790	
167	Instr.		11.567	802.691	196	406,986	
Instr.	168	11.632		814.323	93	407,079	
168	Instr.		6.141	808.182	120	407,199	
Instr.	169		5.052	803.130	119	407,318	
169	Instr.		5.759	797.371	93	407,411	
Instr.	170	4.409		801.780	114	407,525	
170	Instr.		7.326	794.454	120	407,645	Crossing the Hingador.
Instr.	171	18.534		812.988	130	407,775	
171	Instr.	32.656		845.644	123	407,898	
Instr.	172		0.255	845.389	35	407,933	
172	Instr.		40.151	805.238	98	408,031	
Instr.	173		7.992	797.246	92	408,123	Crossing the Hingador.
173	Instr.	23.321		820.567	96	408,219	
Instr.	174		17.519	803.048	88	408,307	
174	Instr.		3.254	799.794	31	408,338	Crossing branch of the Hingador.
Instr.	175	1.840		801.634	115	408,453	
175	Instr.	2.636		804.270	114	408,567	
Instr.	176		0.749	803.521	92	408,659	Crossing a branch twice.
176	Instr.	18.149		821.670	242	408,901	
Instr.	177		2.108	819.562	110	409,011	
177	Instr.		1.455	818.107	115	409,126	
Instr.	178		2.023	816.084	114	409,240	
178	Instr.		4.964	811.120	136	409,376	Crossing creek.
Instr.	179	6.396		817.516	89	409,465	Crossing creek.

TABLE No. II—Continued.

From station.	To station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	Feet.	Feet.	
179	Instr.	14.174		831.690	103	409,568	Campo Las Cabazeras del Hingador. (Headwaters of the Hingador.)
Instr.	180	7.495		839.185	86	409,654	
180	Instr.		7.415	831.770	150	409,804	
Instr.	181		7.344	824.426	164	409,968	
181	Instr.		5.613	818.813	117	410,085	
Instr.	182		4.489	814.324	147	410,232	
182	Instr.	1.731		816.055	140	410,372	Crossing last branch of the Hingador, about 200 feet below Rancho No. 4.
Instr.	183	36.732		852.787	151	410,523	
183	Instr.	5.433		858.220	52	410,575	
Instr.	184		1.623	856.597	125	410,700	
184	Instr.	15.637		872.234	105	410,805	
Instr.	185	1.853		874.087	137	410,942	
185	Instr.		10.063	864.024	134	411,076	
Instr.	186	4.649		868.673	82	411,158	
186	Instr.		9.024	859.649	214	411,372	
Instr.	187	2.568		862.217	45	411,417	
187	Instr.		1.462	860.755	67	411,484	
Instr.	188		2.094	858.661	144	411,628	
188	Instr.	0.095		858.756	82	411,710	
Instr.	189	11.645		870.401	130	411,840	
189	Instr.	21.699		892.100	200	412,040	
Instr.	190		14.915	877.185	162	412,202	
190	Instr,		4.641	872.544	158	412,360	
Instr.	191	1.614		874.158	146	412,506	
191	Instr.		6.279	867.879	96	412,602	
Instr.	192	6.186		874.065	108	412,710	
192	Instr.	9.368		883.433	96	412,806	
Instr.	193	8.755		892.188	107	412,913	
193	Instr.	16.925		909.113	131	413,044	
Instr.	194	1.476		910.589	54	413,098	
194	Instr.	4.938		915.527	79	413,177	
Instr.	195		5.602	909.925	114	413,291	
195	Instr.	1.585		911.510	109	413,400	
Instr.	196	7.565		919.075	107	413,507	
196	Instr.	12.341		931.416	104	413,611	
Instr.	197	16.027		947.443	126	413,737	Principal divide of the waters of the Atlantic and Pacific.
197	Instr.		20.250	927.193	186	413,923	
Instr.	198		11.467	915.726	120	414,043	
198	Instr.		2.804	912.922	189	414,232	
Instr.	199	3.283		916.205	198	414,430	
199	Instr.	1.242		917.447	122	414,552	
Instr.	200	5.687		923.134	127	414,679	
200	Instr.	6.061		929.195	229	414,908	
Instr.	201		4.375	924.820	169	415,077	
201	Instr.		17.645	907.175	111	415,188	
Instr.	202	13.646		920.821	144	415,332	
202	Instr.	11.358		932.179	89	415,421	
Instr.	203		10,618	921.561	96	415,517	
203	Instr.		14.293	907.268	171	415,688	
Instr.	204		7.031	900.237	155	415,843	
204	Instr.		3.810	896.427	58	415,901	
Instr.	205	0.930		897.357	136	416,037	
205	Instr.	4.670		902.027	169	416,206	
Instr.	206		6.576	895.451	190	416,396	
206	Instr.		7.063	888.388	100	416,496	
Instr.	207		14.682	873.706	161	416,657	
207	Instr.	5.340		879.046	153	416,810	
Instr.	208	11.944		890.990	67	416,877	
208	Instr.	18.012		909.002	132	417,009	
Instr.	209	15.896		924.898	131	417,140	
209	Instr.	0.137		925.035	63	417,203	

TABLE No. II—Continued.

From station.	To station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	*Feet.*	*Feet.*	
Instr.	210		31.430	893.605	178	417.381	
210	Instr.		4.577	889.028	130	417,511	
Instr.	211	22.933		911.961	218	417,729	
211	Instr.	19.990		931.951	106	417,835	
Instr.	212		1.255	930.696	83	417,918	
212	Instr.		3.235	927.461	228	418,146	
Instr.	213		5.677	921.784	137	418,283	
213	Instr.		23.829	897.955	133	418,416	
Instr.	214		17.164	880.791	207	418,623	
214	Instr.		5.533	875.258	65	418,688	
Instr.	215		5.612	869.646	201	418,889	
215	Instr.	1.851		871.497	95	418,984	Head of valley on the left; branch of Rio Chuperador.
Instr.	216	18.075		889.572	203	419,187	
216	Instr.		13.882	875.690	100	419,287	
Instr.	217		29.334	846.356	132	419,419	Campo Chuperador.
217	Instr.	2.251		848.607	86	419,505	
Instr.	C.R.		13.335	835.272	35	419,540	Rio Chuperador.
	218	29.664		878.271	122	419,627	
218	Instr.	11.921		890.192	95	419,722	
Instr.	219	15.238		905.430	189	419,911	
219	Instr.		0.968	904.462	104	420,015	
Instr.	220		7.464	896.998	132	420,147	
220	Instr.		16.126	880.872	167	420,314	
Instr.	221		13.216	867.656	139	420,453	
221	Instr.	10.059		877.715	80	420,533	
Instr.	222		5.420	872.295	109	420,642	
222	Instr.		17.524	854.771	109	420,751	
Instr.	223	16.299		871.070	108	420,859	
223	Instr.	0.436		871.506	100	420,959	
Instr.	224		6.977	864.529	80	421,039	
224	Instr.		7.125	857.404	114	421,153	
Instr.	225	12.974		870.378	116	421,269	
225	Instr.	9.714		880.092	121	421,390	
Instr.	226	9.546		889.638	103	421,493	
226	Instr.	6.716		896.354	149	421,642	
Instr.	227	24.473		920.827	225	421,867	
227	Instr.	9.342		930.169	108	421,975	
Instr.	228	21.120		951.289	158	422,133	
228	Instr.	31.281		982.570	228	422,361	
Instr.	229		0.477	982.093	82	422,443	
229	Instr.		22.316	959.777	129	422,572	
Instr.	230	5.055		964.832	220	422,792	
230	Instr.	4.997		969.829	142	422,934	
Instr.	231		26.381	943.448	209	423,143	
231	Instr.		13.893	929.555	87	423,230	
Instr.	232		20.044	909.511	104	423,334	
232	Instr.		28.514	880.997	118	423,452	
Instr.	Qu.		16.851	864.146	84	423,536	Bed of Quebrada, descending towards the left. Rancho No. 3; Campo Los Charcos.
	233	1.920		882.917	132	423,584	
233	Instr.	25.970		908.887	98	423,682	
Instr.	234	23.507		932.394	125	423,807	
234	Instr.	27.836		960.230	176	423,983	
Instr.	235	18.137		978.367	154	424,137	
235	Instr.		5.341	973.026	57	424,194	
Instr.	236		7.751	965.275	62	424,256	
236	Instr.		15.239	950.036	74	424,330	
Instr.	237		5.758	944.278	123	424,453	
237	Instr.		5.029	939.249	92	424,545	
Instr.	238		8.937	930.312	123	424,668	
238	Instr.		2.201	928.111	88	424,756	
Instr.	239	7.778		935.889	101	424,857	

TABLE No. II—Continued.

From station.	To station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	*Feet.*	*Feet.*	
239	Instr.	0.359		936.248	95	424,952	
Instr.	240		11.092	925.156	113	425,065	
240	Instr.		18.511	906.645	128	425,193	
Instr.	241	11.693		918.338	121	425,314	On a fallen tree, 2 feet and 2 inches high.
241	Instr.	9.149		927.487	72	425,386	
Instr.	242	13.385		940.872	143	425,529	
242	Instr.	6.744		947.616	91	425,620	
Instr.	243		11.383	936.233	125	425,745	
243	Instr.		14.880	921.353	113	425,858	
Instr.	244		22.311	899.042	229	426,087	
244	Instr.	28.038		927.080	173	426,260	
Instr.	245		0.377	926.703	108	426,368	
245	Instr.		16.343	910.360	143	426,511	
Instr.	246		5.958	904.402	109	426,620	
246	Instr.		7.811	896.591	133	426,753	
Instr.	247		24.181	872.410	144	426,897	
247	Instr.		22.160	850.250	155	427,052	
Instr.	248	14.332		864.582	146	427,198	
248	Instr.		10.001	854.581	94	427,292	
Instr.	249		10.313	844.268	165	427,457	
249	Instr.		2.638	841.630	81	427,538	
Instr.	250		1.641	839.989	120	427,658	
250	Instr.	6.450		846.439	118	427,776	
Instr.	251		4.628	841.811	109	427,885	
251	Instr.		7.801	834.010	79	427,964	
Instr.	252		7.030	826.980	113	428,077	
252	Instr.		4.489	822.491	147	428,224	
Instr.	253		1.908	820.583	82	428,306	
253	Instr.		6.330	814.253	62	428,368	
Instr.	254		4.005	810.248	162	428,530	
254	Instr.		15.517	794.731	132	428,662	
Instr.	255	18.687		813.418	82	428,744	
255	Instr.		5.318	808.100	127	428,871	
Instr.	256		13.728	794.372	113	428,984	
256	Instr.	5.625		799.997	90	429,074	
Instr.	257	5.777		805.774	137	429,211	
257	Instr.		11.200	794.574	93	429,304	
Instr.	258		20.108	774.466	98	429,402	
258	Instr.		13.327	761.139	76	429,478	
Instr.	259		27.116	734.023	96	429,574	
259	Instr.		9.379	724.644	146	429,720	
Instr.	260		5.584	719.060	98	429,818	
260	Instr.		8.589	710.471	115	429,933	
Instr.	261		4.686	705.785	131	430,064	
261	Instr.	29.716		735.501	117	430,181	
Instr.	262	8.573		744.074	57	430,238	
262	Instr.	16.464		760.538	87	430,325	
Instr.	263	11.310		771.848	117	430,442	
263	Instr.		12.758	759.090	111	430,553	
Instr.	264		17.634	741.456	119	430,672	
264	Instr.		12.944	728.512	126	430,798	
Instr.	265		5.339	723.173	120	430,918	
265	Instr.		24.635	698.538	147	431,065	
Instr.	266		3.537	695.001	160	431,225	
266	Instr.	14.803		709.804	169	431,394	
Instr.	267	17.163		726.967	135	431,529	
267	Instr.		0.298	726.669	38	431,567	
Instr.	268		28.929	697.740	124	431,691	
268	Instr.	4.518		702.258	47	431,738	
Instr.	269		13.607	688.651	131	431,869	
269	Instr.		19.492	669.159	84	431,953	

TABLE No. II—Continued.

From station.	To station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	*Feet.*	*Feet.*	
Instr.	270	10.319		679.478	117	432,070	
270	Instr.		10.751	668.727	84	432,154	
Instr.	271		30.242	638.485	164	432,318	
271	Instr.		5.533	632.952	79	432,397	
Instr.	272		16.513	616.439	101	432,498	
272	Instr.	3.747		620.186	226	432,724	
Instr.	273		13.984	606.202	86	432,810	
273	Instr.		32.662	573.540	125	432,935	
Instr.	274		10.818	562.722	132	433,067	
274	Instr.	5.643		568.365	92	433,159	
Instr.	275	1.596		569.961	111	433,270	
275	Instr.		23.285	546.676	91	433,361	
Instr.	276		15.844	530.832	126	433,487	
276	Instr.		3.012	527.820	167	433,654	
Instr.	277		3.371	524.449	69	433,723	
277	Instr.		18.754	505.695	106	433,829	
Instr.	278		51.381	454.314	118	433,947	
278	Instr.		29.389	424.925	165	434,112	
Instr.	279		9.269	415.656	106	434,218	
279	Instr.		7.988	407.668	75	434,293	
Instr.	280		23.364	384.304	121	434,414	
280	Instr.		1.028	383.276	114	434,528	
Instr.	281	11.295		394.571	106	434,634	
281	Instr.	14.256		408.827	87	434,721	
Instr.	282	2.091		410.918	91	434,812	
282	Instr.		0.363	410.555	96	434,908	
Instr.	283	2.625		413.180	95	435,003	
283	Instr.		23.554	389.626	135	435,138	
Instr.	284		26.532	363.094	135	435,273	
284	Instr.		24.387	338.707	105	435,378	
Instr.	285		14.380	324.327	81	435,459	
285	Instr.		3.441	320.886	136	435,595	
Instr.	F. Ch.		21.540	299.346	— 72	435,523	Crossing tributary of the Rio Chupepe. Fork of trail.
	286	17.496		338.382	164	435,759	
286	Instr.	0.681		339.063	117	435,876	
Instr.	287		30.960	308.103	176	436,052	
287	Instr.	17.755		325.858	167	436,219	
Instr.	288	2.381		328.239	132	436,351	
288	Instr.		16.593	311.646	132	436,483	
Instr.	289	8.000		319.646	181	436,664	
289	Instr.		15.305	304.341	115	436,779	
Instr.	290		20.346	283.995	119	436,898	
290	Instr.		40.870	243.125	176	437,074	
Instr.	F. H.		1.770	241.355	— 69	437,005	Foot of hill.
	291	0.952		244.077	218	437,292	
291	Instr.		0.605	243.472	109	437,401	
Instr.	Ch. R.		11.778	231.694	85	437,486	Bed of Rio Chupepe. Rancho No. 2. Camp. River 30 feet wide; pebbly bottom; flow to the left.
	292	1.985		245.457	130	437,531	
292	Instr.	5.613		251.070	98	437,629	
Instr.	293		1.408	249.662	110	437,739	
293	Instr.		2.344	247.318	155	437,894	
Instr.	294		4.922	242.396	92	437,986	
294	Instr.		5.271	237.125	145	438,131	Crossing tributary of Rio Chupepe; 15 feet wide; pebbly bottom; flow to the left; banks 8 feet high.
Instr.	295		3.673	233.452	164	438,295	
295	Instr.	32.492		265.944	128	438,423	
Instr.	296	13.957		279.901	196	438,619	
296	Instr.	23.141		303.042	143	438,762	
Instr.	297	20.227		323.269	236	438,998	
297	Instr.		5.060	318.209	150	439,148	
Instr.	298	11.200		329.409	85	439,233	
298	Instr.		16.797	312.612	205	439,438	

TABLE No. II—Continued.

From station.	To station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	*Feet.*	*Feet.*	
Instr.	299		5.743	306.869	217	439,655	
299	Instr.		0.782	306.087	1[illegible]	439,848	
Instr.	300		35.051	271.036	11[illegible]	439,963	
300	Instr.		17.018	254.018	157	440,120	
Instr.	B. Cr.		17.202	236.816	78	440,198	Crossing tributary of Rio Chupepe, 10 feet wide; banks 5 feet high.
	301		6.714	247.304	100	440,220	
301	Instr.	29.292		276.596	102	440,322	
Instr.	302	12.197		288.793	88	440,410	
302	Instr.	11.649		300.442	152	440,562	
Instr.	303		1.586	298.856	133	440,695	
303	Instr.	5.714		304.570	131	440,826	
Instr.	304	18.534		323.104	130	440,956	
304	Instr.	55.695		378.799	231	441,187	
Instr.	305	25.353		404.152	144	441,331	
305	Instr.	25.030		429.182	111	441,442	
Instr.	306	1.108		430.290	127	441,569	
306	Instr.	2.071		432.361	141	441,710	
Instr.	307		3.335	429.026	122	441,832	
307	Instr.	0.774		429.800	95	441,927	
Instr.	308		5.484	424.316	115	442,042	
308	Instr.	5.935		430.251	74	442,116	
Instr.	309	2.832		433.083	118	442,234	
309	Instr.	10.675		443.758	179	442,413	
Instr.	310	0.607		444.365	138	442,551	
310	Instr.		11.176	433.189	99	442,650	
Instr.	311		16.220	416.969	101	442,751	
311	Instr.		10.688	406.281	170	442,921	
Instr.	312	16.387		422.668	119	443,040	
312	Instr.		11.796	410.872	139	443,179	
Instr.	313		9.771	401.101	118	443,297	
313	Instr.		7.637	393.464	132	443,429	
Instr.	314	20.571		414.035	134	443,563	
314	Instr.	4.537		418.572	195	443,758	
Instr.	315	2.183		420.755	112	443,870	
315	Instr.	0.037		420.792	127	443,997	
Instr.	316	8.309		429.101	113	444,110	
316	Instr.		1.529	427.572	147	444,257	
Instr.	317	23.114		450.686	103	444,360	
317	Instr.		15.073	435.613	144	444,504	
Instr.	318	1.747		437.360	91	444,595	
318	Instr.		3.573	433.787	173	444,768	
Instr.	319		8.449	425.338	69	444,837	
319	Instr.		14.345	410.993	138	444,975	
Instr.	320		6.959	404.034	128	445,103	
320	Instr.		3.244	400.790	164	445,267	
Instr.	321		5.423	395.367	88	445,355	
321	Instr.	7.259		402.626	62	445,417	
Instr.	322		8.429	394.197	93	445,510	
322	Instr.		7.277	386.920	191	445,701	
Instr.	323		4.249	382.671	79	445,780	
323	Instr.		14.816	367.855	156	445,936	
Instr.	324		12.431	355.424	67	446,003	
324	Instr.		28.570	326.854	129	446,132	
Instr.	325		7.919	318.935	114	446,246	
325	Instr.		8.283	310.652	114	446,360	
Instr.	326		4.459	306.193	86	446,446	
326	Instr.		27.906	278.287	149	446,595	
Instr.	327		24.634	253.653	141	446,736	
327	Instr.		9.234	244.419	254	446,990	
Instr.	328		2.015	242.404	108	447,098	
328	Instr.		13.713	228.691	160	447,258	

TABLE No. II—Continued.

From station.	To station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	*Feet.*	*Feet.*	
Instr.	329	18.114		246.805	126	447,384	
329	Instr.		5.210	241.595	98	447,482	
Instr.	330		16.125	225.470	105	447,587	
330	Instr.		19.733	205.737	99	447,686	
Instr.	331		54.180	151.557	136	447,822	Cascade on the right to be heard.
331	Instr.		10.631	140.926	136	447,958	Very narrow crest.
Instr.	332	0.942		141.868	83	448,041	
332	Instr.		5.992	135.876	33	448,074	
Instr.	333		42.790	93.086	134	448,208	
333	Instr.		33.671	59.415	136	448,344	On the Pie de Nercua.
Instr.	334		2.345	57.070	96	448,440	
334	335		2.86	54.21	260	448,700	Dos Bocas. Confluence of the Pie de Nercua with another stream from the right.
335	336		2.80	51.41	185	448,885	
336	337		2.31	49.10	185	449,070	
337	338		0.43	48.67	210	449,280	
338	339		3.60	45.07	245	449,525	Closely above 339: Barometrical station; height, 45.30.
339	340		1.65	43.42	275	449,800	
340	341		2.66	40.76	315	450,115	
341	342		0.82	39.94	350	450,465	
342	343		3.11	36.83	400	450,865	
343	344		2.14	34.69	265	451,130	
344	345		2.50	32.19	355	451,485	
345	346		2.03	30.16	395	451,880	
346	347		1.73	28.43	380	452,260	
347	348		1.87	26.56	430	452,690	
348	349		2.40	24.16	490	453,180	
349	350		1.84	22.32	540	453,720	
350	351		1.42	20.90	380	454,100	Rancho No. 1. Campo Pie de Nercua.
351	352		2.50	18.40	385	454,485	
352	353		0.08	18.32	290	454,775	Junction of the Pie de Nercua and Rio Totumia, each 50 feet wide
353	354		1.35	16.97	785	455,560	Rio Totumia after confluence 80 feet wide.
354	355		1.12	15.85	560	456,120	
355	356		1.70	14.15	810	456,930	Clearing on the right.
356	357		2.20	11.95	1225	458,155	
357	358		2.73	9.22	415	458,570	
358	359		0.64	8.58	580	459,150	
359	360	0.02		8.60	810	459,960	
360	361		1.06	7.54	710	460,670	Rancho of the Alcalde of Paracuchichi. Last hill on the left.
361	362		0.49	7.05	570	461,240	
362	363	0.48		7.53	370	461,610	Rancho on the left.
363	364		2.56	4.97	670	462,280	
364	365		0.24	4.73	340	462,620	
365	366		0.20	4.53	530	463,150	
366	367		0.82	3.71	400	463,550	
367	368		0.69	3.02	540	464,090	
368	369		0.30	2.72	150	464,240	
369	370		0.25	2.47	510	464,750	
370	371		1.60	0.87	660	465,410	
371	372	0.18		1.05	395	465,805	Opposite Domingo's rancho.
372	373	0.13		1.18	460	466,265	
373	374	0.87		2.05	765	467,030	Extreme tidal marks.
374	375		1.88	0.17	405	467,435	Commencement of the Mangrove region.
375	376	2.41		2.58	410	467,845	
376	377		2.60	− 0.02	470	468,315	
377	378	0.62		+ 0.60	625	468,940	
378	379		1.90	− 1.30	590	469,530	
379	380		1.44	− 2.74	920	470,450	

TABLE No. II—Continued.

From station.	To station.	Plus.	Minus.	Above sea level.	Interm. distance.	Distance from 169.	Remarks.
				Feet.	*Feet.*	*Feet.*	
380	381	1.56		— 1.18	740	471,190	
381	382		0.13	— 1.31	1510	472,700	Mouth of Rio Totumia.
382	383	7.21		+ 5.90	2245	474,945	Across Bahia Ensenada, (Kelley's inlet.)
383	*b.*	3.15		9.05	2155	477,100	On Isla de la Playa.
b.	*o.*		4.75	4.30	1600	478,700	Barometrical station on Isla de la Playa; height, 9.10.
o.	H. T.	0.61		4.91	—	478,700	High tide on February 8, 1858.
H. T.	I. Pt.		4.60	0.31	250	478,945	Intermediate point.
I. Pt.	L. T.		5.21	— 4.90	370	479,320	Low tide on Feb. 8, 1858.
L. T.	M. T.	4.90		0.00	—	479,320	Mean tide of Pacific Ocean.

TABLE No. III.

OF CORRECTIONS FROM APPARENT LEVEL TO TRUE LEVEL.

COMPUTED BY JOHN DE LA CAMP.

Backsight.			Foresight.			True level.		Remarks.
From instr. to—	Length.	Amount of curvature.	From instr. to—	Length.	Amount of curvature.	Above apparent level.	Below apparent level.	
						Feet.	*Feet.*	
169	50	0.0002	170	2420	0.1401		0.1399	Highest point of shore at Sucio. Salaqui—mouth of the Truandó.
170	950	0.0216	171	2590	0.1605		0.1389	
171	1470	0.0517	172	1540	0.0567		0.0050	Mouth of Sucio river.
172	1510	0.0545	173	1295	0.0401	0.0144		Boca Caimanero of the Truandó.
173	1510	0.0545	174	485	0.0057	0.0488		
174	1525	0.0556	175	570	0.0077	0.0479		
175	1000	0.0239	176	560	0.0075	0.0164		
176	700	0.0117	177	750	0.0134		0.0017	
177	820	0.0161	178	700	0.0117	0.0044		
178	840	0.0169	179	790	0.0149	0.0020		
179	535	0.0068	180	450	0.0049	0.0019		
180	720	0.0124	181	960	0.0221		0.0097	
181	1115	0.0297	182	1100	0.0289	0.0008		
182	735	0.0129	183	350	0.0030	0.0099		Separation of Salaqui—channel.
183	610	0.0089	184	720	0.0124		0.0035	
184	640	0.0098	185	1155	0.0319		0.0221	
185	610	0.0089	186	660	0.0105		0.0016	
186	600	0.0086	187	1015	0.0246		0.0160	
187	660	0.0105	188	805	0.0155		0.0050	
188	520	0.0065	189	565	0.0076		0.0011	
189	670	0.0108	190	640	0.0098	0.0010		
190	840	0.0169	191	390	0.0037	0.0132		
191	635	0.0096	192	270	0.0018	0.0078		
192	565	0.0076	193	1120	0.0300		0.0224	
193	550	0.0072	194	680	0.0111		0.0039	
194	910	0.0199	195	475	0.0055	0.0144		
195	890	0.0190	196	1225	0.0358		0.0168	
196	670	0.0108	197	550	0.0072	0.0036		
197	890	0.0190	198	805	0.0155	0.0035		
198	860	0.0178	199	735	0.0129	0.0049		Campo Abertura.
199	1030	0.0253	200	750	0.0134	0.0119		
200	1000	0.0239	201	550	0.0072	0.0167		
201	965	0.0223	202	945	0.0214	0.0009		
202	900	0.0194	203	790	0.0149	0.0045		
203	1525	0.0556	204	605	0.0088	0.0468		Fishing rancho.
204	660	0.0105	205	700	0.0117		0.0012	
205	890	0.0190	206	820	0.0161	0.0029		
206	850	0.0173	207	890	0.0190		0.0017	Fishing rancho.
207	1140	0.0311	208	1020	0.0248	0.0063		
208	540	0.0070	209	1235	0.0364		0.0294	
209	545	0.0071	210	835	0.0167		0.0096	
210	1040	0.0258	211	1070	0.0273		0.0015	

TABLE No. III—Continued.

Backsight.			Foresight.			True level.		Remarks.
From instr. to—	Length.	Amount of curvature.	From instr. to—	Length.	Amount of curvature.	Above apparent level.	Below apparent level.	
						Feet.	*Feet.*	
211	1310	0.0410	212	630	0.0095	0.0315		
212	960	0.0221	213	920	0.0203	0.0018		
213	690	0.0114	214	530	0.0067	0.0047		
214	585	0.0081	215	495	0.0059	0.0022		
215	825	0.0163	216	360	0.0032	0.0131		
216	1245	0.0370	217	960	0.0221	0.0149		
217	675	0.0109	218	665	0.0107	0.0002		
218	355	0.0031	219	455	0.0051		0.0020	
219	750	0.0134	220	1170	0.0327		0.0193	
220	700	0.0117	221	730	0.0127		0.0010	
221	670	0.0108	222	385	0.0036	0.0072		
222	1100	0.0289	223	870	0.0182	0.0107		Rancho La Clarita.
223	440	0.0047	224	495	0.0059		0.0012	
224	890	0.0190	225	200	0.0010	0.0180		Campo Clarita.
225	375	0.0034	226	410	0.0041		0.0007	
226	425	0.0044	227	320	0.0025	0.0019		
227	245	0.0014	228	530	0.0067		0.0053	
228	390	0.0037	229	330	0.0027	0.0010		
229	395	0.0038	230	620	0.0092		0.0054	
230	605	0.0087	231	1050	0.0263		0.0176	
231	500	0.0060	232	185	0.0009	0.0051		
232	525	0.0066	233	1070	0.0273		0.0207	
233	790	0.0149	234	860	0.0178		0.0029	
234	425	0.0044	235	880	0.0186		0.0142	
235	490	0.0058	236	1155	0.0319		0.0261	
236	605	0.0087	237	420	0.0043	0.0044		
237	445	0.0048	238	1745	0.0728		0.0680	
238	1190	0.0338	239	2275	0.1239		0.0901	
239	1035	0.0255	240	2245	0.1207		0.0952	
240	940	0.0212	241	1800	0.0775		0.0563	
241	685	0.0112	242	610	0.0089	0.0023		
242	685	0.0112	243	840	0.0169		0.0057	
243	1015	0.0246	244	1680	0.0675		0.0429	
244	860	0.0178	245	850	0.0173	0.0005		Foot of the Palizadas.
245	1120	0.0300	246	470	0.0054	0.0246		
246	290	0.0021	247	420	0.0043	0.0022		Campo Quita Palos.
247	145	0.0005	248	490	0.0058		0.0053	
248	585	0.0081	249	275	0.0019	0.0062		
249	555	0.0073	250	50	0.0001	0.0072		
250	455	0.0050	251	235	0.0014	0.0036		
251	225	0.0012	252	700	0.0117		0.0105	Punta Buenaventura.
252	685	0.0112	253	230	0.0013	0.0099		
253	370	0.0033	254	240	0.0014	0.0019		
254	495	0.0059	255	210	0.0011	0.0048		
255	370	0.0033	256	205	0.0011	0.0022		
256	970	0.0225	257	270	0.0018	0.0207		
257	330	0.0027	258	1155	0.0319		0.0292	Commencement of the lab-
258	230	0.0013	259	385	0.0036		0.0023	yrinth of islands.
259	305	0.0023	260	790	0.0149		0.0126	
260	535	0.0068	261	90	0.0002	0.0066		Barometrical station.
261	240	0.0014	262	385	0.0036		0.0022	
262	310	0.0024	263	100	0.0003	0.0021		
263	290	0.0021	264	680	0.0111		0.0090	
264	410	0.0041	265	195	0.0010	0.0031		Campo Las Isletas.
265	340	0.0028	266	665	0.0107		0.0079	

TABLE No. III—Continued.

Backsight.			Foresight.			True level.		Remarks.
From instr. to—	Length.	Amount of curvature.	From instr. to—	Length.	Amount of curvature.	Above apparent level.	Below apparent level.	
						Feet.	*Feet.*	
266	320	0.0025	267	385	0.0036		0.0011	
267	550	0.0072	268	340	0.0028	0.0044		
268	195	0.0009	269	400	0.0039		0.0030	
269	910	0.0199	270	340	0.0028	0.0171		
270	515	0.0064	271	385	0.0036	0.0028		
271	225	0.0012	272	275	0.0019		0.0007	
272	680	0.0111	273	140	0.0005	0.0106		
273	215	0.0011	274	440	0.0047		0.0036	
274	185	0.0008	275	540	0.0070		0.0062	
275	455	0.0050	276	280	0.0019	0.0031		
276	575	0.0078	277	170	0.0007	0.0071		
277	365	0.0032	278	385	0.0036		0.0004	
278	190	0.0009	279	145	0.0006	0.0003		
279	330	0.0027	280	720	0.0124		0.0097	
280	735	0.0129	281	990	0.0234		0.0105	Campo Resumpcion.
281	595	0.0084	282	70	0.0002	0.0082		
282	640	0.0098	283	290	0.0021	0.0077		
283	520	0.0065	284	220	0.0012	0.0053		
284	260	0.0017	285	480	0.0056		0.0039	
285	360	0.0032	286	290	0.0021	0.0011		
286	490	0.0058	287	265	0.0018	0.0040		
287	195	0.0009	288	535	0.0069		0.0060	
288	270	0.0018	289	300	0.0022		0.0004	
289	365	0.0032	290	395	0.0038		0.0006	
290	350	0.0030	291	435	0.0046		0.0016	
291	660	0.0105	292	245	0.0015	0.0090		
292	210	0.0011	293	235	0.0014		0.0003	
293	440	0.0047	294	400	0.0039	0.0008		
294	195	0.0009	295	555	0.0074		0.0065	
295	205	0.0010	296	195	0.0010	....	....	
296	315	0.0024	297	310	0.0024	....	....	
297	415	0.0042	298	270	0.0018	0.0024		
298	295	0.0021	299	260	0.0017	0.0004		
299	190	0.0009	301	110	0.0003	0.0006		
301	100	0.0003	302	160	0.0006		0.0003	Campo Las Palizadas. Called First Camp in report.
302	260	0.0017	303	215	0.0012	0.0005		Barometrical station.
303	215	0.0011	304	180	0.0008	0.0003		
304	350	0.0030	305	160	0.0006	0.0024		
305	130	0.0004	306	220	0.0012		0.0008	
306	110	0.0003	307	150	0.0006		0.0003	
307	110	0.0003	308	190	0.0009		0.0006	
308	430	0.0045	309	150	0.0006	0.0039		
309	235	0.0013	310	80	0.0002	0.0011		
310	375	0.0034	311	325	0.0026	0.0008		
311	15	0.0000	312	240	0.0014		0.0014	
312	230	0.0013	313	230	0.0013	....	....	
313	155	0.0006	314	210	0.0011		0.0005	
314	395	0.0038	315	420	0.0043		0.0005	
315	510	0.0063	316	240	0.0014	0.0049		
316	130	0.0004	317	295	0.0022		0.0018	
317	200	0.0010	318	150	0.0006	0.0004		
318	195	0.0009	319	210	0.0011		0.0002	
319	280	0.0019	320	300	0.0022		0.0003	Island.

TABLE No. III—Continued.

Backsight.			Foresight.			True level.		Remarks.
From instr. to—	Length.	Amount of curvature.	From instr. to—	Length.	Amount of curvature.	Above apparent level.	Below apparent level.	
						Feet.	*Feet.*	
320	585	0.0081	321	340	0.0028	0.0053		
321	220	0.0012	322	200	0.0010	0.0002		
322	90	0.0009	323	820	0.0161		0.0152	
323	470	0.0054	324	280	0.0019	0.0035		
324	135	0.0004	325	260	0.0017		0.0013	
325	190	0.0009	326	570	0.0077		0.0068	
326	340	0.0028	327	130	0.0004	0.0024		
327	530	0.0067	328	135	0.0005	0.0062		
328	575	0.0078	329	510	0.0063	0.0015		
329	335	0.0027	330	50	0.0001	0.0026		Camp. Tambo de José Maria Tocame.
330	95	0.0002	331	450	0.0049		0.0047	
331	370	0.0033	332	125	0.0004	0.0029		
332	500	0.0060	333	290	0.0021	0.0039		
333	330	0.0027	334	250	0.0015	0.0012		
334	110	0.0003	335	205	0.0011		0.0008	
335	115	0.0003	336	335	0.0028		0.0025	
336	430	0.0045	337	425	0.0044	0.0001		
337	430	0.0045	338	110	0.0003	0.0042		
338	250	0.0015	339	280	0.0019		0.0004	
339	80	0.0002	340	495	0.0059		0.0057	
340	480	0.0056	341	290	0.0021	0.0035		
341	410	0.0041	342	265	0.0018	0.0023		
342	405	0.0040	343	200	0.0010	0.0030		
343	315	0.0024	344	380	0.0035		0.0011	
344	160	0.0006	345	710	0.0121		0.0115	
345	160	0.0006	346	740	0.0131		0.0125	
346	160	0.0006	347	220	0.0012		0.0006	
347	400	0.0039	348	205	0.0011	0.0028		
348	365	0.0032	349	330	0.0027	0.0005		
349	755	0.0136	350	260	0.0017	0.0119		
350	395	0.0038	351	160	0.0006	0.0032		
351	170	0.0007	352	390	0.0037		0.0030	
352	335	0.0027	353	220	0.0012	0.0015		Great Palisade.
353	260	0.0017	354	120	0.0004	0.0013		
354	130	0.0004	355	265	0.0018		0.0014	
355	330	0.0027	356	225	0.0013	0.0014		
356	380	0.0035	357	215	0.0012	0.0023		
357	75	0.0002	358	695	0.0116		0.0114	Great Palisade.
358	590	0.0083	359	890	0.0190		0.0107	Head of the Palizadas.
359	355	0.0031	360	760	0.0138		0.0107	
360	655	0.0103	361	680	0.0111		0.0008	
361	365	0.0032	362	875	0.0184		0.0152	
362	690	0.0114	363	820	0.0161		0.0047	
363	1245	0.0370	364	970	0.0225	0.0145		
364	690	0.0114	365	325	0.0026	0.0088		
365	540	0.0070	366	1010	0.0244		0.0174	
366	690	0.0114	367	1260	0.0379		0.0265	
367	610	0.0089	368	430	0.0045	0.0044		
368	390	0.0037	369	1260	0.0379		0.0342	
369	1280	0.0391	370	860	0.0178	0.0213		
370	760	0.0138	371	730	0.0127	0.0011		
371	1410	0.0476	372	1150	0.0316	0.0160		
372	760	0.0138	373	880	0.0186		0.0048	
373	1015	0.0246	374	830	0.0165	0.0081		
374	740	0.0131	375	465	0.0053	0.0078		Campo de Caiman.

TABLE No. III—Continued.

Backsight.			Foresight.			True level.		Remarks.
From instr. to—	Length.	Amount of curvature.	From instr. to—	Length.	Amount of curvature.	Above apparent level.	Below apparent level.	
						Feet.	*Feet.*	
375	870	0.0182	376	780	0.0145	0.0037		
376	1190	0.0338	377	960	0.0221	0.0117		
377	550	0.0072	378	755	0.0136		0.0064	
378	300	0.0022	379	450	0.0049		0.0027	
379	845	0.0171	380	1155	0.0319		0.0148	
380	830	0.0165	381	860	0.0178		0.0013	
381	1250	0.0373	382	550	0.0072	0.0301		
382	875	0.0184	383	1960	0.0920		0.0736	
383	475	0.0055	384	910	0.0199		0.0144	
384	420	0.0043	385	550	0.0072		0.0029	
385	1190	0.0338	386	375	0.0034	0.0304		
386	1275	0.0388	387	1020	0.0248	0.0140		Mouth of Rio Salado.
387	780	0.0145	388	825	0.0163		0.0018	
388	475	0.0055	389	525	0.0066		0.0011	
389	1090	0.0284	390	630	0.0095	0.0189		
390	580	0.0080	391	530	0.0067	0.0013		
391	245	0.0014	392	750	0.0134		0.0120	
392	1100	0.0289	393	1120	0.0300		0.0011	
393	1540	0.0567	394	1000	0.0239	0.0328		
394	1280	0.0391	395	1155	0.0319	0.0072		
395	630	0.0095	396	610	0.0089	0.0006		
396	800	0.0153	397	1200	0.0344		0.0191	
397	465	0.0053	398	1120	0.0300		0.0247	
398	1365	0.0446	399	1070	0.0273	0.0173		
399	800	0.0153	400	680	0.0111	0.0042		
400	550	0.0072	401	680	0.0111		0.0039	
401	860	0.0178	402	820	0.0161	0.0017		
402	620	0.0092	403	1075	0.0276		0.0184	Foot of the Rapids.
403	480	0.0056	404	665	0.0107		0.0051	
404	510	0.0063	405	1365	0.0446		0.0383	Quebrada Peña baja.
405	1070	0.0273	406	650	0.0101	0.0172		
406	105	0.0003	407	480	0.0056		0.0053	
407	260	0.0017	408	85	0.0002	0.0015		Campo Pie de los Saltos.
408	60	0.0001	409	290	0.0021		0.0020	
409	85	0.0002	1	310	0.0024		0.0022	
1	515	0.0064	2	345	0.0029	0.0035		
2	390	0.0037	3	100	0.0003	0.0034		
3	670	0.0108	4	150	0.0006	0.0102		Rio Escalero or Calderon.
4	270	0.0018	5	230	0.0013	0.0005		Large Cataract.
5	180	0.0008	6	460	0.0052		0.0044	
6	440	0.0047	7	750	0.0134		0.0087	Campo De los Saltos.
7	210	0.0011	8	360	0.0032		0.0021	Rancho.
8	385	0.0036	9	600	0.0086		0.0050	
9	320	0.0025	10	1020	0.0248		0.0223	
10	680	0.0111	11	510	0.0063	0.0048		
11	840	0.0169	12	1010	0.0244		0.0075	Campo El Puerto del Tru-
12	450	0.0049	13	645	0.0100		0.0051	andó. Quebrada Peña
13	820	0.0161	14	380	0.0035	0.0126		alta.
14	650	0.0101	15	735	0.0129		0.0028	
15	750	0.0134	16	1250	0.0373		0.0239	
16	590	0.0083	17	400	0.0039	0.0044		
17	850	0.0173	18	540	0.0070	0.0103		Head of Truandó Falls.
18	620	0.0092	19	505	0.0062	0.0030		
19	1350	0.0436	20	450	0.0049	0.0387		
20	945	0.0214	21	580	0.0080	0.0134		

TABLE No. III—Continued.

Backsight.			Foresight.			True level.		Remarks.
From instr. to—	Length.	Amount of curvature.	From instr. to—	Length.	Amount of curvature.	Above apparent level.	Below apparent level.	
						Feet.	*Feet.*	
21	1090	0.0284	22	810	0.0157	0.0127		
22	1120	0.0300	23	520	0.0065	0.0235		
23	1080	0.0279	24	945	0.0214	0.0065		
24	620	0.0092	25	890	0.0190		0.0098	
25	525	0.0066	26	870	0.0182		0.0116	Playa de la Wunga.
26	1420	0.0483	27	670	0.0108	0.0375		
27	1285	0.0394	28	1190	0.0338	0.0056		
28	600	0.0086	29	530	0.0067	0.0019		
29	540	0.0070	30	800	0.0153		0.0083	Mouth of Rio Nercua
30	480	0.0056	31	760	0.0138		0.0082	Tambo de José. Camp
31	425	0.0044	32	720	0.0124		0.0080	
32	375	0.0034	33	640	0.0098		0.0064	
33	240	0.0014	34	615	0.0091		0.0077	
34	280	0.0019	35	510	0.0063		0.0044	
35	405	0.0040	36	370	0.0033	0.0007		
36	850	0.0173	37	560	0.0075	0.0098		
37	670	0.0108	38	510	0.0063	0.0045		
38	125	0.0004	39	365	0.0033		0.0029	
39	225	0.0012	40	600	0.0086		0.0074	
40	280	0.0019	41	415	0.0042		0.0023	Mouth of Rio Grand
41	540	0.0070	42	600	0.0086		0.0016	(Oodor.)
42	250	0.0015	43	610	0.0089		0.0074	
43	280	0.0019	44	450	0.0049		0.0030	
44	490	0.0058	45	305	0.0023	0.0035		
45	70	0.0002	46	425	0.0044		0.0042	
46	355	0.0031	47	400	0.0039		0.0008	
47	190	0.0009	48	445	0.0048		0.0039	
48	290	0.0021	49	275	0.0019	0.0002		
49	570	0.0077	50	350	0.0030	0.0047		
50	450	0.0049	51	425	0.0044	0.0005		
51	630	0.0095	52	350	0.0030	0.0065		
52	500	0.0060	53	460	0.0052	0.0008		
53	435	0.0046	54	310	0.0024	0.0022		
54	385	0.0036	55	600	0.0086		0.0050	Campo Agua Caliente.
55	360	0.0032	56	495	0.0059		0.0027	
56	395	0.0038	57	390	0.0037	0.0001		Hot sulphur spring.
57	320	0.0025	58	325	0.0026		0.0001	
58	340	0.0028	59	590	0.0083		0.0055	
59	470	0.0054	60	205	0.0011	0.0043		
60	800	0.0153	61	415	0.0042	0.0111		
61	650	0.0101	62	465	0.0053	0.0048		
62	665	0.0106	63	960	0.0221		0.0115	
63	245	0.0014	64	330	0.0027		0.0013	Mouth of Rio Equebrado
64	390	0.0037	65	805	0.0155		0.0118	
65	290	0.0021	66	350	0.0030		0.0009	
66	400	0.0039	67	560	0.0075		0.0036	
67	270	0.0018	68	280	0.0019		0.0001	
68	320	0.0025	69	410	0.0041		0.0016	
69	190	0.0009	70	810	0.0157		0.0148	
70	120	0,0004	71	890	0.0190		0.0186	
71	280	0.0019	72	210	0.0011	0.0008		
72	620	0.0092	73	450	0.0049	0.0043		
73	415	0.0042	74	210	0.0011	0.0031		
74	555	0.0073	75	660	0.0105		0.0032	
75	500	0.0060	76	300	0.0022	0.0038		

TABLE No. III—Continued.

Backsight.			Foresight.			True level.		Remarks.
From instr. to—	Length.	Amount of curvature.	From instr. to—	Length.	Amount of curvature.	Above apparent level.	Below apparent level.	
						Feet.	*Feet.*	
76	395	0.0038	77	535	0.0069		0.0031	
77	755	0.0136	78	540	0.0070	0.0066		
78	500	0.0060	79	485	0.0057	0.0003		
79	370	0.0033	80	760	0.0138		0.0105	
80	330	0.0027	81	550	0.0072		0.0045	Campo Playa Bonita.
81	350	0.0030	82	450	0.0049		0.0019	
82	450	0.0049	83	290	0.0021	0.0028		
83	610	0.0089	84	1070	0.0273		0.0184	
84	210	0.0011	85	320	0.0025		0.0014	
85	760	0.0138	86	340	0.0028	0.0110		
86	250	0.0015	87	435	0.0046		0.0031	
87	365	0.0032	88	235	0.0014	0.0018		
88	390	0.0037	89	330	0.0027	0.0010		
89	940	0.0212	90	270	0.0018	0.0194		
90	455	0.0050	91	295	0.0022	0.0028		Rio Paravador.
91	640	0.0098	92	450	0.0049	0.0049		
92	990	0.0234	93	890	0.0190	0.0044		
93	860	0.0178	94	525	0.0066	0.0112		
94	645	0.0099	95	430	0.0045	0.0054		
95	760	0.0138	96	965	0.0223		0.0085	
96	530	0.0067	97	690	0.0114		0.0047	
97	445	0.0048	98	450	0.0049		0.0001	
98	380	0.0035	99	670	0.0108		0.0073	
99	625	0.0093	100	720	0.0124		0.0031	
100	305	0.0023	101	730	0.0127		0.0104	
101	390	0.0037	102	630	0.0095		0.0058	
102	750	0.0134	103	645	0.0100	0.0034		Lower mouth of Rio Hingador
103	210	0.0011	104	355	0.0031		0.0020	Upper mouth of Rio Hingador.
104	200	0.0010	105	185	0.0009	0.0001		
105	160	0.0006	106	130	0.0004	0.0002		
106	105	0.0003	107	190	0.0009		0.0006	
107	85	0.0002	108	100	0.0003		0.0001	
108	100	0.0003	109	125	0.0004		0.0001	
109	60	0.0001	110	210	0.0011		0.0010	
110	400	0.0039	111	380	0.0035	0.0004		
111	185	0.0008	112	195	0.0010		0.0002	
112	160	0.0006	113	310	0.0024		0.0018	
113	130	0.0004	114	190	0.0009		0.0005	
114	140	0.0005	115	150	0.0006		0.0001	Hot spring.
115	180	0.0008	116	110	0.0003	0.0005		Hot spring.
116	440	0.0047	117	220	0.0012	0.0035		
117	180	0.0008	118	120	0.0004	0.0004		
118	280	0.0019	119	185	0.0009	0.0010		
119	150	0.0006	120	205	0.0011		0.0005	
120	245	0.0014	121	150	0.0006	0.0008		
121	80	0.0002	122	280	0.0019		0.0017	
122	315	0.0024	123	220	0.0012	0.0012		
123	140	0.0005	124	155	0.0006		0.0001	
124	85	0.0002	125	205	0.0011		0.0009	
125	215	0.0011	126	115	0.0004	0.0007		
126	165	0.0006	127	130	0.0004	0.0002		
127	240	0.0014	128	170	0.0007	0.0007		
128	130	0.0004	129	110	0.0003	0.0001		
129	115	0.0003	130	120	0.0004		0.0001	Cataract, five feet high.

TABLE No. III—Continued.

Backsight.			Foresight.			True level.		Remarks.
From instr. to—	Length.	Amount of curvature.	From instr. to—	Length.	Amount of curvature.	Above apparent level.	Below apparent level.	
						Feet.	*Feet.*	
130	170	0.0007	131	125	0.0004	0.0003		
131	150	0.0006	132	105	0.0003	0.0003		
132	185	0.0008	133	95	0.0003	0.0005		
133	200	0.0010	134	190	0.0009	0.0001		
134	120	0.0004	135	200	0.0010		0.0006	
135	155	0.0006	136	200	0.0010		0.0004	
136	135	0.0004	137	160	0.0006		0.0002	
137	170	0.0007	138	160	0.0006	0.0001		Campo Sombroso.
138	215	0.0011	139	90	0.0002	0.0009		
139	155	0.0006	140	120	0.0004	0.0002		
140	120	0.0004	141	240	0.0014		0.0010	
141	170	0.0007	142	100	0.0003	0.0004		
142	160	0.0006	143	90	0.0002	0.0004		
143	50	0.0001	144	10	....	0.0001		Foot of the cataracts of the
144	35	0.0001	145	0	....	0.0001		Hingador.
145	0	....	146	0	....	....	....	
146	70	0.0002	147	66	0.0001	0.0001		
147	30	0.0001	148	35	0.0001	....	....	
148	40	0.0001	149	8	....	0.0001		
149	20	....	150	25	....	....	....	Top of the cataracts of the
150	45	0.0001	151	80	0.0002		0.0001	Hingador.
151	231	0.0013	152	150	0.0006	0.0007		
152	104	0.0003	153	155	0.0006		0.0003	Campo del Salto.
153	105	0.0003	154	138	0.0005		0.0002	
154	188	0.0009	155	267	0.0018		0.0009	Great fall of the Hingador.
155	101	0.0003	156	120	0.0004		0.0001	
156	81	0.0002	157	62	0.0001	0.0001		
157	40	0.0001	158	159	0.0006		0.0005	
158	123	0.0004	159	67	0.0002	0.0002		
159	109	0.0003	160	145	0.0006		0.0003	
160	119	0.0004	161	40	0.0001	0.0003		Tree-crossing of the Hin-
161	72	0.0002	162	45	0.0001	0.0001		gador.
162	66	0.0002	163	70	0.0002	....	....	
163	82	0.0002	164	69	0.0002	....	....	
164	74	0.0002	165	77	0.0002	....	....	
165	51	0.0001	166	63	0.0002		0.0001	
166	78	0.0002	167	75	0.0002	....	....	
167	196	0.0009	168	93	0.0003	0.0006		
168	120	0.0004	169	119	0.0004	....	....	
169	93	0.0002	170	114	0.0004		0.0002	
170	120	0.0004	171	130	0.0004	....	....	
171	123	0.0004	172	35	0.0001	0.0003		
172	98	0.0003	173	92	0.0002	0.0001		
173	96	0.0002	174	88	0.0002	....	....	
174	31	0.0001	175	115	0.0004		0.0003	
175	114	0.0003	176	92	0.0002	0.0001		
176	242	0.0014	177	109	0.0003	0.0011		
177	115	0.0004	178	114	0.0004	....	....	
178	136	0.0005	179	89	0.0002	0.0003		
179	103	0.0003	180	86	0.0002	0.0001		Campo las Cabazeras del
180	150	0.0006	181	164	0.0007		0.0001	Hingador.
181	116	0.0004	182	147	0.0006		0.0002	
182	140	0.0005	183	151	0.0006		0.0001	Crossing last branch of the
183	52	0.0001	184	124	0.0004		0.0003	Hingador; Rancho No. 4.
184	105	0.0003	185	137	0.0005		0.0002	

TABLE No. III—Continued.

Backsight.			Foresight.			True level.		Remarks.
From instr. to—	Length.	Amount of curvature.	From instr. to—	Length.	Amount of curvature.	Above apparent level.	Below apparent level.	
						Feet.	*Feet.*	
185	134	0.0004	186	82	0.0002	0.0002		
186	214	0.0011	187	45	0.0001	0.0010		
187	67	0.0002	188	144	0.0005		0.0003	
188	82	0.0002	189	130	0.0004		0.0002	
189	200	0.0010	190	162	0.0006	0.0004		
190	158	0.0006	191	146	0.0006	....	....	
191	96	0.0003	192	107	0.0003	....	....	
192	96	0.0003	193	107	0.0003	....	....	
193	131	0.0004	194	54	0.0001	0.0003		
194	79	0.0002	195	114	0.0003		0.0001	
195	109	0.0003	196	107	0.0003	....	....	
196	104	0.0003	197	126	0.0004		0.0001	Principal divide of the waters of the Atlantic and Pacific.
197	186	0.0009	198	120	0.0004	0.0005		
198	189	0.0009	199	198	0.0010		0.0001	
199	122	0.0004	200	127	0.0004	0.0006		
200	229	0.0013	201	169	0.0007	....	....	
201	111	0.0003	202	144	0.0005		0.0002	
202	89	0.0002	203	96	0.0003		0.0001	
203	171	0.0007	204	155	0.0006	0.0001		
204	57	0.0001	205	136	0.0005		0.0004	
205	169	0.0007	206	190	0.0009		0.0002	
206	100	0.0003	207	161	0.0006		0.0003	
207	152	0.0006	208	67	0.0002	0.0004		
208	132	0.0004	209	131	0.0004	....	....	
209	63	0.0001	210	178	0.0008		0.0007	
210	129	0.0004	211	218	0.0012		0.0008	
211	106	0.0003	212	83	0.0002	0.0001		
212	227	0.0013	213	137	0.0005	0.0008		
213	133	0.0004	214	207	0.0011		0.0007	
214	65	0.0006	215	201	0.0010		0.0004	
215	95	0.0002	216	203	0.0010		0.0008	Branch of Rio Chuperador.
216	100	0.0003	217	131	0.0004		0.0001	
217	86	0.0002	218	122	0.0004		0.0002	Campo Chuperador.
218	95	0.0002	219	189	0.0009		0.0007	Rio Chuperador.
219	104	0.0003	220	132	0.0004		0.0001	
220	167	0.0007	221	139	0.0005	0.0002		
221	80	0.0002	222	109	0.0003		0.0001	
222	109	0.0003	223	108	0.0003	....	....	
223	100	0.0003	224	80	0.0002	0.0001		
224	114	0.0004	225	116	0.0004	....	....	
225	121	0.0004	226	103	0.0003	0.0001		
226	149	0.0006	227	225	0.0012		0.0006	
227	108	0.0003	228	158	0.0006		0.0003	
228	228	0.0013	229	82	0.0002	0.0011		
229	129	0.0004	230	220	0.0012		0.0008	
230	142	0.0005	231	209	0.0011		0.0006	
231	87	0.0002	232	104	0.0003		0.0001	
232	118	0.0004	233	132	0.0004	....	....	Campo los Charcos. Rancho No. 3, Quebrada.
233	98	0.0003	234	125	0.0004		0.0001	
234	174	0.0008	235	152	0.0006	0.0002		
235	57	0.0001	236	62	0.0001	....	....	
236	74	0.0002	237	123	0.0004		0.0002	
237	92	0.0002	238	123	0.0004		0.0002	
238	88	0.0002	239	101	0.0003		0.0001	
239	95	0.0002	240	113	0.0003		0.0001	

TABLE No. III—Continued.

Backsight.			Foresight.			True level.		Remarks.
From instr. to—	Length.	Amount of curvature.	From instr. to—	Length.	Amount of curvature.	Above apparent level.	Below apparent level.	
						Feet.	*Feet.*	
240	128	0.0004	241	121	0.0004	....	....	
241	72	0.0002	242	143	0.0005		0.0003	
242	91	0.0002	243	125	0.0004		0.0002	
243	113	0.0003	244	229	0.0013		0.0010	
244	174	0.0007	245	108	0.0003	0.0004		
245	143	0.0005	246	109	0.0003	0.0002		
246	133	0.0004	247	144	0.0005		0.0001	
247	155	0.0006	248	146	0.0006	....	....	
248	94	0.0002	249	165	0.0007		0.0005	
249	81	0.0002	250	120	0.0004		0.0002	
250	118	0.0004	251	109	0.0003	0.0001		
251	79	0.0002	252	113	0.0003		0.0001	
252	147	0.0006	253	82	0.0002	0.0004		
253	62	0.0001	254	162	0.0006		0.0005	
254	132	0.0004	255	82	0.0002	0.0002		
255	127	0.0004	256	113	0.0003	0.0001		
256	90	0.0002	257	137	0.0005		0.0003	
257	93	0.0002	258	98	0.0003		0.0001	
258	76	0.0002	259	96	0.0003		0.0001	
259	146	0.0006	260	98	0.0003	0.0003		
260	115	0.0003	261	131	0.0004		0.0001	
261	117	0.0004	262	57	0.0001	0.0003		
262	87	0.0002	263	117	0.0004		0.0002	
263	111	0.0003	264	119	0.0004		0.0001	
264	126	0.0004	265	120	0.0004	....	....	
265	147	0.0006	266	160	0.0006	....	....	
266	169	0.0007	267	135	0.0005	0.0002		
267	38	0.0001	268	124	0.0004		0.0003	
268	46	0.0001	269	131	0.0004		0.0003	
269	84	0.0002	270	117	0.0004		0.0002	
270	84	0.0002	271	164	0.0006		0.0004	
271	79	0.0002	272	101	0.0003		0.0001	
272	226	0.0003	273	86	0.0002	0.0011		
273	125	0.0004	274	132	0.0004	....	....	
274	92	0.0002	275	111	0.0003		0.0001	
275	91	0.0002	276	126	0.0004		0.0002	
276	167	0.0007	277	69	0.0002	0.0005		
277	106	0.0003	278	117	0.0004		0.0001	
278	165	0.0006	279	106	0.0003	0.0003		
279	75	0.0002	280	121	0.0004		0.0002	
280	114	0.0003	281	106	0.0003	....	....	
281	87	0.0002	282	91	0.0002	....	....	
282	96	0.0003	283	95	0.0003	....	....	
283	135	0.0005	284	135	0.0005	....	....	
284	105	0.0003	285	81	0.0002	0.0001		
285	136	0.0005	286	165	0.0007		0.0002	Tributary of Rio Chupepe.
286	117	0.0004	287	176	0.0008		0.0004	
287	167	0.0007	288	132	0.0004	0.0003		
288	132	0.0004	289	181	0.0008		0.0004	
289	116	0.0004	290	119	0.0004	....	....	
290	176	0.0008	291	218	0.0012		0.0004	
291	109	0.0003	292	129	0.0004		0.0001	Rio Chupepe. Camp. Rancho No. 2.
292	98	0.0003	293	110	0.0003	....	....	
293	155	0.0006	294	92	0.0002	0.0004		
294	145	0.0005	295	164	0.0006		0.0001	Tributary of Rio Chupepe.

TABLE No. III—Continued.

Backsight.			Foresight.			True level.		Remarks.
From instr. to—	Length.	Amount of curvature.	From instr. to—	Length.	Amount of curvature.	Above apparent level.	Below apparent level.	
						Feet.	*Feet.*	
295	128	0.0004	296	196	0.0010		0.0006	
296	143	0.0005	297	235	0.0014		0.0009	
297	150	0.0006	298	85	0.0002	0.0004		
298	205	0.0010	299	217	0.0012		0.0002	
299	192	0.0009	300	115	0.0004	0.0005		
300	157	0.0006	301	100	0.0003	0.0003		Tributary of Rio Chupepe.
301	102	0.0003	302	88	0.0002	0.0001		
302	152	0.0006	303	133	0.0004	0.0002		
303	131	0.0004	304	130	0.0004	....	....	
304	231	0.0013	305	144	0.0005	0.0008		
305	111	0.0003	306	127	0.0004		0.0001	
306	141	0.0005	307	122	0.0004	0.0001		
307	95	0.0002	308	115	0.0003		0.0001	
308	74	0.0002	309	118	0.0004		0.0002	
309	179	0.0008	310	139	0.0005	0.0003		
310	99	0.0003	311	101	0.0003	....	....	
311	170	0.0007	312	119	0.0004	0.0003		
312	139	0.0005	313	117	0.0004	0.0001		
313	132	0.0004	314	134	0.0004	....	....	
314	195	0.0009	315	111	0.0003	0.0006		
315	127	0.0004	316	112	0.0003	0.0001		
316	146	0.0006	317	103	0.0003	0.0003		
317	144	0.0005	318	91	0.0002	0.0003		
318	173	0.0007	319	69	0.0002	0.0005		
319	138	0.0005	320	128	0.0004	0.0001		
320	164	0.0006	321	88	0.0002	0.0004		
321	62	0.0001	322	93	0.0002		0.0001	
322	191	0.0009	323	79	0.0002	0.0007		
323	156	0.0006	324	67	0.0002	0.0004		
324	129	0.0004	325	114	0.0003	0.0001		
325	114	0.0003	326	86	0.0002	0.0001		
326	149	0.0006	327	142	0.0005	0.0001		
327	254	0.0016	328	108	0.0003	0.0013		
328	160	0.0006	329	126	0.0004	0.0002		
329	98	0.0003	330	105	0.0003	....	....	
330	99	0.0003	331	136	0.0005		0.0002	
331	136	0.0005	332	83	0.0002	0.0003		
332	33	0.0001	333	134	0.0004		0.0003	
333	136	0.0005	334	96	0.0003	0.0002		Pie de Nercua.
334	70	0.0002	335	190	0.0009		0.0007	Dos Bocas.
335	60	0.0001	336	125	0.0004		0.0003	
336	85	0.0002	337	100	0.0003		0.0001	
337	105	0.0003	338	105	0.0003	....	....	
338	120	0.0004	339	125	0.0004	....	....	
339	175	0.0007	340	100	0.0003	0.0004		Barometrical station
340	185	0.0008	341	130	0.0004	0.0004		
341	245	0.0014	342	105	0.0003	0.0011		
342	160	0.0006	343	240	0.0014		0.0008	
343	85	0.0002	344	180	0.0008		0.0006	
344	245	0.0014	345	110	0.0003	0.0011		
345	145	0.0005	346	250	0.0015		0.0010	
346	160	0.0006	347	220	0.0012		0.0006	
347	355	0.0031	348	75	0.0002	0.0029		
348	335	0.0027	349	155	0.0006	0.0021		
349	340	0.0028	350	200	0.0010	0.0018		

TABLE No. III—Continued.

Backsight.			Foresight.			True level.		Remarks.
From instr. to—	Length.	Amount of curvature.	From instr. to—	Length.	Amount of curvature.	Above apparent level.	Below apparent level.	
						Feet.	*Feet.*	
350	120	0.0004	351	260	0.0017		0.0013	Campo Pie de Nercua.
351	105	0.0003	352	280	0.0019		0.0016	Rancho No. 1.
352	60	0.0001	353	230	0.0013		0.0012	Junction of Pie de Nercua and Rio Totumia.
353	450	0.0049	354	335	0.0028	0.0021		
354	330	0.0027	355	230	0.0013	0.0014		
355	290	0.0021	356	520	0.0065		0.0044	
356	1020	0.0248	357	205	0.0011	0.0237		
357	185	0.0008	358	230	0.0013		0.0005	
358	290	0.0021	359	290	0.0021	....	....	
359	290	0.0021	360	520	0.0065		0.0044	
360	250	0.0015	361	460	0.0052		0.0037	Rancho of the Alcalde of Paracuchichi.
361	180	0.0008	362	390	0.0037		0.0029	
362	160	0.0006	363	210	0.0011		0.0005	
363	300	0.0022	364	370	0.0033		0.0011	
364	90	0.0002	365	250	0.0015		0.0013	
365	290	0.0021	366	240	0.0014	0.0007		
366	295	0.0021	367	105	0.0003	0.0018		
367	270	0.0018	368	270	0.0018	....	....	
368	40	0.0001	369	110	0.0003		0.0002	
369	185	0.0008	370	325	0.0026		0.0018	
370	500	0.0060	371	160	0.0006	0.0054		
371	250	0.0015	372	145	0.0006	0.0009		Rancho of Domingo.
372	130	0.0004	373	330	0.0027		0.0023	
373	595	0.0084	374	170	0.0007	0.0077		Extreme tidal marks.
374	130	0.0004	375	275	0.0019		0.0015	
375	230	0.0013	376	180	0.0008	0.0005		
376	235	0.0013	377	235	0.0014		0.0001	
377	200	0.0010	378	425	0.0044		0.0034	
378	295	0.0021	379	295	0.0022		0.0001	
379	670	0.0108	380	250	0.0015	0.0093		
380	490	0.0058	381	250	0.0015	0.0043		
381	590	0.0083	382	920	0.0203		0.0120	Mouth of Rio Totumia.
282	1295	0.0401	383	950	0.0216	0.0185		Bahia Ensenada. (Kelley's Inlet.)
383	635	0.0096	*b*	1520	0.0552		0.0456	Isla de la Playa.
b	1100	0.0289	0	500	0.0060	0.0229		Astronomical station at Campo La Playa.

TABLE No. IV.

OF READINGS AND COMPUTATIONS OF ANGLES OF ELEVATION AND DEPRESSION ACROSS THE CORDILLERAS DE LOS ANDES, MEASURED WITH THEODOLITE NO. 1.

COMPUTED BY JOHN DE LA CAMP.

From station.	To station.	Distance reading.	Length of sight.	Angle of elevation.	Angle of depression.	Intermediate difference of height.		Horizontal distance.	Remarks.
						Plus.	Minus.		
				° '	° '	*Feet.*	*Feet.*		
151	Instr.	1.81	231	2 48½		11.318		231	
Instr.	152	1.18	150	— 36½		1.593		150	
152	Instr.	0.82	104	2 40½		4.854		104	Campo del Salto.
Instr.	153	1.22	155	3 39½		9.890		155	
153	Instr.	0.83	105	2 16½		4.168		105	
Instr.	154	1.09	139	2 09½		5.235		138	
154	Instr.	1.48	189	3 11		10.495		188	
Instr.	155	2.34	300	27 10		136.974		267	Head of Hingador Fall.
	F. F.	0.54	68	6 22		7.53		68	Foot of Fall.
155	Instr.	0.80	101	1 37		2.849		101	
Instr.	156	0.95	120		1 45		3.665	120	
156	Instr.	0.64	81		0 34		0.801	81	
Instr.	157	0.50	63	7 50		8.586		62	
157	Instr.	0.32	40		4 30½		3.144	40	
Instr.	158	1.25	159		0 38½		1.781	159	
158	Instr.	0.97	123	1 27½		3.130		123	
Instr.	159	0.53	67		0 25		0.487	67	
159	Instr.	0.86	109	1 20½		2.552		109	
Instr.	160	1.14	145		0 42½		1.793	145	
160	Instr.	0.94	119	1 17		2.665		119	
Instr.	161	0.32	40		0 26		0.303	40	
161	Instr.	0.57	72		2 05		2.617	72	Tree-Crossing of
Instr.	162	0.40	50	24 30½		20.741		45	the Hingador.
162	Instr.	0.54	68	12 30		14.718		66	
Instr.	163	0.56	71	7 52½		9.728		70	
163	Instr.	0.65	82	2 56½		4.208		82	
Instr.	164	0.55	69	6 34		7.891		69	
164	Instr.	0.59	74	6 28½		8.345		74	
Instr.	165	0.61	77		2 20		3.135	77	
165	Instr.	0.42	52		14 22½		12.910	51	
Instr.	166	0.51	64		12 01		13.325	63	
166	Instr.	0.62	78		4 19		5.871	78	
Instr.	167	0.60	76		5 33½		7.361	75	
167	Instr.	1.54	196		3 23		11.567	196	
Instr.	168	0.74	94	7 06½		11.632		93	
168	Instr.	0.95	120		2 56		6.141	120	
Instr.	169	0.94	119		2 26		5.052	119	
169	Instr.	0.74	93		3 33		5.759	93	
Instr.	170	0.90	114	2 13		4.409		114	
170	Instr.	0.95	120		3 30		7.326	120	Crossing the Hin-
Instr.	171	1.03	131	8 08		18.534		130	gador.

TABLE No. IV—Continued.

From station.	To station.	Distance reading.	Length of sight.	Angle of elevation.	Angle of depression.	Intermediate difference of height. Plus.	Intermediate difference of height. Minus.	Horizontal distance.	Remarks.
				° ′	° ′	*Feet.*	*Feet.*		
171	Instr.	1.00	127	14 54		32.656		123	
Instr.	172	0.28	35		0 25		0.255	35	
172	Instr.	0.84	106		22 15½		40.151	98	
Instr.	173	0.73	92		4 59		7.992	92	Crossing the Hingador.
173	Instr.	0.78	99	13 37½		23.321		96	
Instr.	174	0.71	90		11 13½		17.519	88	
174	Instr.	0.25	31		6 01½		3.254	31	
Instr.	175	0.91	115	0 55		1.840		115	
175	Instr.	1.90	114	1 19½		2.636		114	
Instr.	176	0.73	92		0 28		0.749	92	
176	Instr.	0.90	243	4 17		18.149		242	
Instr.	177	0.86	109		1 06½		2.108	109	
177	Instr.	0.91	115		0 43½		1.455	115	
Instr.	178	0.90	114		1 01		2.023	114	
178	Instr.	1.07	136		2 05½		4.964	136	
Instr.	179	0.71	90	4 04½		6.396		89	
179	Instr.	0.82	104	7 50		14.174		103	Campo Las Cabazeras del Hingador.
Instr.	180	0.68	86	5 00		7.495		86	
180	Instr.	1.18	150		2 50		7.415	150	
Instr.	181	1.29	164		2 34		7.344	164	
181	Instr.	0.92	117		2 45		5.613	116	
Instr.	182	1.16	147		1 45		4.489	147	
182	Instr.	1.10	140	0 42½		1.731		140	Crossing the last branch of the Hingador. Rancho No. 4.
Instr.	183	1.22	155	13 42½		36.732		151	
183	Instr.	0.42	53	5 53		5.433		52	
Instr.	184	0.98	124		0 45		1.623	125	
184	Instr.	0.84	106	8 29		15.637		105	
Instr.	185	1.08	137	0 46½		1.853		137	
185	Instr.	1.06	135		4 16½		10.063	134	
Instr.	186	0.65	82	3 15		4.649		82	
186	Instr.	1.68	214		2 25		9.024	214	
Instr.	187	0.36	46	3 12		2.568		45	
187	Instr.	0.53	67		1 15		1.462	67	
Instr.	188	1.13	144		0 50		2.094	144	
188	Instr.	0.65	82	0 04		0.095		82	
Instr.	189	1.03	131	5 06		11.645		130	
189	Instr.	1.58	202	6 10		21.699		200	
Instr.	190	1.28	163		5 15		14.915	162	
190	Instr.	1.24	158		1 41		4.641	158	
Instr.	191	1.15	146	0 38		1.614		146	
191	Instr.	0.76	96		3 45		6.279	96	
Instr.	192	0.85	108	3 17		6.186		107	
192	Instr.	0.76	96	5 36		9.368		96	
Instr.	193	0.85	108	4 39		8.755		107	
193	Instr.	1.04	132	7 22		16.925		131	
Instr.	194	0.43	54	1 34		1.476		54	
194	Instr.	0.63	79	3 35		4.938		79	
Instr.	195	0.90	114		2 49		5.602	114	
195	Instr.	0.86	109	0 50		1.585		109	
Instr.	196	0.85	108	4 01		7.565		107	
196	Instr.	0.83	105	6 45		12.341		104	
Instr.	197	1.00	127	7 15		16.027		126	Principal divide of the waters of the Atlantic and Pacific.
197	Instr.	1.47	187		6 13		20.250	186	
Instr.	198	0.95	120		5 29		11.467	120	
198	Instr.	1.48	189		0 51		2.804	189	
Instr.	199	1.55	198	0 57		3.283		198	

TABLE No. IV—Continued.

From station.	To station.	Distance reading.	Length of sight.	Angle of elevation.	Angle of depression.	Intermediate difference of height. Plus.	Intermediate difference of height. Minus.	Horizontal distance.	Remarks.
				° ′	° ′	Feet.	Feet.		
199	Instr.	0.96	122	0 35		1.242		122	
Instr.	200	1.00	127	2 34		5.687		127	
200	Instr.	1.79	229	1 31		6.061		229	
Instr.	201	1.33	169		1 29		4.375	169	
201	Instr.	0.89	113		8 59		17.645	111	
Instr.	202	1.14	145	5 24		13.646		144	
202	Instr.	0.71	90	7 15		11.358		89	
Instr.	203	0.76	96		6 21		10.618	96	
203	Instr.	1.35	172		4 46		14.293	171	
Instr.	204	1.22	155		2 36½		7.031	155	
204	Instr.	0.46	58		3 46		3.810	57	
Instr.	205	1.07	136	0 23½		0.930		136	
205	Instr.	1.33	169	1 35		4.670		169	
Instr.	206	1.49	190		1 59		6.576	190	
206	Instr.	0.79	100		4 03		7.063	100	
Instr.	207	1.27	162		5 12		14.682	161	
207	Instr.	1.20	153	2 00		5.340		153	
Instr.	208	0.54	68	10 07		11.944		67	
208	Instr.	1.05	133	7 47		18.012		132	
Instr.	209	1.04	132	6 55		15.896		131	
209	Instr.	0.50	63	0 07½		0.137		63	
Instr.	210	1.42	181		10 00		31.430	178	
210	Instr.	1.02	129		2 02		4.577	129	
Instr.	211	1.72	220	5 59		22.933		218	
211	Instr.	0.85	108	10 40		19.990		106	
Instr.	212	0.66	83		0 52		1.255	83	
212	Instr.	1.78	227		0 49		3.235	227	
Instr.	213	1.08	137		2 22½		5.677	137	
213	Instr.	1.06	135		10 10		23.829	133	
Instr.	214	1.63	208		4 44		17.164	207	
214	Instr.	0.52	65		4 53		5.533	65	
Instr.	215	1.58	201		1 36		5.612	201	
215	Instr.	0.75	95	1 07		1.851		95	Tributary of Rio
Instr.	216	1.60	204	5 05		18.075		203	Chuperador.
216	Instr.	0.80	101		7 54		13.882	100	
Instr.	217	1.06	135		12 33		29.334	131	Campo Chupera-
217	Instr.	0.68	86	1 30		2.251		86	dor.
Instr.	R. C.	0.30	38		20 39		13.335	35	Rio Chuperador.
	218	0.99	126	13 37		29.664		122	
218	Instr.	0.76	96	7 08		11.921		95	
Instr.	219	1.49	190	4 36		15.238		189	
219	Instr.	0.82	104		0 32		0.968	104	
Instr.	220	1.04	132		3 14½		7.464	132	
220	Instr.	1.32	168		5 30½		16.126	167	
Instr.	221	1.10	140		5 25		13.216	139	
221	Instr.	0.64	81	7 08		10.059		80	
Instr.	222	0.86	109		2 51		5.420	109	
222	Instr.	0.87	110		9 10		17.524	109	
Instr.	223	0.86	109	8 36		16.299		108	
223	Instr.	0.79	100	0 15		0.436		100	
Instr.	224	0.64	81		4 56½		6.977	80	
224	Instr.	0.90	114		3 35		7.125	114	
Instr.	225	0.92	117	6 22		12.974		116	
225	Instr.	0.96	122	4 34		9.714		121	
Instr.	226	0.82	104	5 16		9.546		103	
226	Instr.	1.17	149	2 35		6.716		149	

TABLE No. IV—Continued.

From station.	To station.	Distance reading.	Length of sight.	Angle of elevation.	Angle of depression.	Intermediate difference of height. Plus.	Intermediate difference of height. Minus.	Horizontal distance.	Remarks.
				° ′	° ′	*Feet.*	*Feet.*		
Instr.	227	1.77	226	6 13		24.473		225	
227	Instr.	0.86	109	4 55		9.342		108	
Instr.	228	1.25	159	7 38		21.120		158	
228	Instr.	1.80	230	7 49		31.281		228	
Instr.	229	0.65	82		0 20		0.477	82	
229	Instr.	1.03	131		9 48½		22.316	129	
Instr.	230	1.72	220	1 19		5.055		220	
230	Instr.	1.12	142	2 01		4.997		142	
Instr.	231	1.65	210		7 13		26.381	209	
231	Instr.	0.70	88		9 05		13.893	87	
Instr.	232	0.84	106		10 54		20.044	104	
232	Instr.	0.96	122		13 31		28.514	118	
Instr.	Qu.	0.68	86		11 19		16.851	84	Quebrada, flowin
	233	1.04	132	0 50		1.920		132	into Chuperador
233	Instr.	0.80	101	14 54		25.970		98	Rancho No. 3
Instr.	234	1.00	127	10 40		23.507		125	Campo Los Char
234	Instr.	1.38	176	9 06		27.836		174	cos.
Instr.	235	1.20	153	6 49½		18.182		151	
235	Instr.	0.46	58		5 17		5.341	57	
Instr.	236	0.50	63		7 04		7.751	62	
236	Instr.	0.60	76		11 34		15.239	74	
Instr.	237	0.97	123		2 41		5.758	123	
237	Instr.	0.73	92		3 08		5.029	92	
Instr.	238	0.97	123		4 10		8.937	123	
238	Instr.	0.70	88		1 26		2.201	88	
Instr.	239	0.80	101	4 25		7.778		101	
239	Instr.	0.75	95	0 13		0.359		95	
Instr.	240	0.90	114		5 35		11.092	113	
240	Instr.	1.02	129		8 15		18.511	128	
Instr.	241	0.96	122	5 30		11.693		121	
241	Instr.	0.58	73	7 12		9.149		72	
Instr.	242	1.13	144	5 20		13.385		143	
242	Instr.	0.72	91	4 15		6.744		91	
Instr.	243	0.99	126		5 11		11.383	125	
243	Instr.	0.90	114		7 30		14.880	113	
Instr.	244	1.80	230		5 34		22.311	229	
244	Instr.	1.38	176	9 10		28.038		174	
Instr.	245	0.85	108		0 12		0.377	108	
245	Instr.	1.13	144		6 31		16.343	143	
Instr.	246	0.86	109		3 08		5.958	109	
246	Instr.	1.05	133		3 22		7.811	133	
Instr.	247	1.15	146		9 32		24.981	144	
247	Instr.	1.23	156		8 10		22.160	155	
Instr.	248	1.15	146	5 38		14.332		146	
248	Instr.	0.75	95		6 03		10.001	94	
Instr.	249	1.30	165		3 35		10.313	165	
249	Instr.	0.64	81		1 52		2.638	81	
Instr.	250	0.95	120		0 47		1.641	120	
250	Instr.	0.93	118	3 08		6.450		118	
Instr.	251	0.86	109		2 26		4.628	109	
251	Instr.	0.63	79		5 40		7.801	79	
Instr.	252	0.89	113		3 34		7.030	113	
252	Instr.	1.16	147		1 45		4.489	147	
Instr.	253	0.65	82		1 20		1.908	82	
253	Instr.	0.50	63		5 46		6.330	62	
Instr.	254	1.27	162		1 25		4.005	162	

TABLE No. IV—Continued.

From station.	To station.	Distance reading.	Length of sight.	Angle of elevation.	Angle of depression.	Intermediate difference of height. Plus.	Intermediate difference of height. Minus.	Horizontal distance.	Remarks.
				° ′	° ′	Feet.	Feet.		
254	Instr.	1.05	133		6 42		15.517	132	
Instr.	255	0.67	85	12 42		18.687		83	
255	Instr.	1.00	127		2 24		5.318	127	
Instr.	256	0.90	114		6 55		13.728	113	
256	Instr.	0.71	90	3 35		5.625		90	
Instr.	257	1.08	137	2 25		5.777		137	
257	Instr.	0.74	93		6 55		11.200	93	
Instr.	258	0.79	100		11 36		20.108	98	
258	Instr.	0.61	77		9 58		13.327	76	
Instr.	259	0.79	100		15 44		27.116	96	
259	Instr.	1.15	146		3 41		9.379	146	
Instr.	260	0.78	99		3 14		5.584	99	
260	Instr.	0.91	115		4 17		8.589	115	
Instr.	261	1.03	131		2 03		4.686	131	
261	Instr.	0.95	121	14 13		29.716		117	
Instr.	262	0.46	58	8 30		8.573		57	
262	Instr.	0.70	88	10 47		16.464		87	
Instr.	263	0.93	118	5 30		11.310		117	
263	Instr.	0.88	111		6 36		12.758	110	
Instr.	264	0.95	120		8 27		17.634	119	
264	Instr.	1.00	127		5 51		12.944	126	
Instr.	265	0.95	120		2 33		5.339	120	
265	Instr.	1.17	149		9 31		24.635	147	
Instr.	266	1.26	160		1 16		3.537	160	
266	Instr.	1.33	169	5 01½		14.803		169	
Instr.	267	1.07	136	7 15		17.163		135	
267	Instr.	0.30	38		0 27		0.298	38	
Instr.	268	1.00	127		13 10		28.929	124	
268	Instr.	0.37	47	5 31		4.518		47	
Instr.	269	1.04	132		5 55		13.607	131	
269	Instr.	0.68	86		13 06		19.492	84	
Instr.	270	0.93	118	5 01		10.319		117	
270	Instr.	0.67	85		7 16		10.751	84	
Instr.	271	1.31	167		10 26		30.242	164	
271	Instr.	0.64	81		3 55		5.533	81	
Instr.	272	0.81	102		9 19		16.513	101	
272	Instr.	1.77	226	0 57		3.747		226	
Instr.	273	0.69	87		9 15		13.984	86	
273	Instr.	1.02	129		14 40		32.662	125	
Instr.	274	1.04	132		4 42		10.818	132	
274	Instr.	0.73	92	3 31		5.643		92	
Instr.	275	0.88	112	0 49		1.596		111	
275	Instr.	0.74	93		14 30		23.285	90	
Instr.	276	1.00	127		7 10		15.844	126	
276	Instr.	1.31	167		1 02		3.012	167	
Instr.	277	0.55	69		2 48		3.371	69	
277	Instr.	0.85	108		10 00		18.754	106	
Instr.	278	1.01	128		23 40		51.381	117	
278	Instr.	1.32	168		10 04½		29.389	165	
Instr.	279	0.84	106		5 01		9.269	106	
279	Instr.	0.60	76		6 02		7.988	75	
Instr.	280	0.97	123		10 57		23.364	121	
280	Instr.	0.90	114		0 31		1.028	114	
Instr.	281	0.84	106	6 07		11.295		106	
281	Instr.	0.70	88	9 19½		14.256		87	
Instr.	282	0.72	91	1 19		2.091		91	

TABLE No. IV—Continued.

From station.	To station.	Distance reading.	Length of sight.	Angle of elevation.	Angle of depression.	Intermediate difference of height. Plus.	Intermediate difference of height. Minus.	Horizontal distance.	Remarks.
				° ′	° ′	Feet.	Feet.		
282	Instr.	0.76	96		0 13		0.363	96	
Instr.	283	0.75	95	1 35		2.625		95	
283	Instr.	1.08	137		9 54		23.554	135	
Instr.	284	1.08	137		11 10		26.532	135	
284	Instr.	0.85	108		13 03		24.387	105	
Instr.	285	0.65	82		10 06		14.380	81	
285	Instr.	1.07	136		1 27		3.441	136	
Instr.	T.Ch.	0.60	76		16 33		21.54	72	Tributary of Rio
	286	1.30	166	6 03		17.496		165	Chupepe. Fork of
286	Instr.	0.92	117	0 20		0.681		117	trail.
Instr.	287	1.40	178		10 01		30.960	176	
287	Instr.	1.32	168	6 04		17.755		167	
Instr.	288	1.04	132	1 02		2.381		132	
288	Instr.	1.05	133		7 10		16.593	132	
Instr.	289	1.42	181	2 32		8.000		181	
289	Instr.	0.92	117		7 31		15.305	116	
Instr.	290	0.96	122		9 36		20.346	119	
290	Instr.	1.42	181		13 03		40.870	176	
Instr.	F.H.	0.55	69		1 28		1.77	69	Foot of hill.
	291	1.71	218	0 15		0.952		218	
291	Instr.	0.86	109		0 19		0.605	109	
Instr.	Ch.R.	0.68	86		7 53		11.78	85	Rio Chupepe. Ran-
	292	1.02	130	0 52½		1.985		129	cho No.2. Camp.
292	Instr.	0.78	99	3 15		5.613		98	
Instr.	293	0.87	110		0 44		1.408	110	
293	Instr.	1.22	155		0 52		2.344	155	
Instr.	294	0.73	92		3 04		4.922	92	
294	Instr.	1.14	145		2 05		5.271	145	Tributary of Rio
Instr.	295	1.29	164		1 17		3.673	164	Chupepe.
295	Instr.	1.04	132	14 15		32.492		128	
Instr.	296	1.54	196	4 05		13.957		196	
296	Instr.	1.14	145	9 11		23.141		143	
Instr.	297	1.85	236	4 55		20.227		236	
297	Instr.	1.18	150		1 56		5.060	150	
Instr.	298	0.68	86	7 29		11.200		85	
298	Instr.	1.61	205		4 42		16.797	205	
Instr.	299	1.70	217		1 31		5.743	217	
299	Instr.	1.51	192		0 14		0.782	192	
Instr.	300	0.95	120		16 59		35.051	115	
300	Instr.	1.24	158		6 11		17.018	157	
Instr.	T.Ch.	0.63	80		12 25		17.20	78	Tributary of Rio
	301	0.79	100		3 51		6.714	100	Chupepe.
301	Instr.	0.84	106	16 01½		29.292		102	
Instr.	302	0.70	88	7 58		12.197		87	
302	Instr.	1.20	153	4 22		11.649		152	
Instr.	303	1.05	133		0 41		1.586	133	
303	Instr.	1.03	131	2 30		5.714		131	
Instr.	304	1.03	131	8 08		18.534		130	
304	Instr.	1.86	238	13 32		55.695		231	
Instr.	305	1.15	146	10 00		25.353		144	
305	Instr.	0.90	114	12 41		25.030		111	
Instr.	306	1.00	127	0 30		1.108		127	
306	Instr.	1.11	141	0 50½		2.071		141	
Instr.	307	0.96	122		1 34		3.335	122	
307	Instr.	0.75	95	0 28		0.774		95	
Instr.	308	0.91	115		2 44		5.484	115	

TABLE No. IV—Continued.

From station.	To station.	Distance reading.	Length of sight.	Angle of elevation.	Angle of depression.	Intermediate difference of height. Plus.	Intermediate difference of height. Minus.	Horizontal distance.	Remarks.
				° ′	° ′	Feet.	Feet.		
308	Instr.	0.59	74	4 36		5.935		74	
Instr.	309	0.93	118	1 22½		2.832		118	
309	Instr.	1.41	180	3 24		10.675		179	
Instr.	310	1.09	139	0 15		0.607		139	
310	Instr.	0.79	100		6 25		11.176	99	
Instr.	311	0.81	102		9 09		16.220	101	
311	Instr.	1.34	171		3 35		10.688	170	
Instr.	312	0.95	121	7 47		16.387		119	
312	Instr.	1.10	140		4 50		11.796	139	
Instr.	313	0.93	118		4 45		9.771	117	
313	Instr.	1.04	132		3 19		7.637	132	
Instr.	314	1.07	136	8 42		20.571		134	
314	Instr.	1.53	195	1 20		4.537		195	
Instr.	315	0.88	112	1 07		2.183		112	
315	Instr.	1.00	127	0 01		0.037		127	
Instr.	316	0.89	113	4 13		8.309		112	
316	Instr.	1.15	146		0 36		1.529	146	
Instr.	317	0.83	105	12 43		23.114		103	
317	Instr.	1.14	145		5 58		15.073	144	
Instr.	318	0.72	91	1 06		1.747		91	
318	Instr.	1.36	173		1 11		3.573	173	
Instr.	319	0.55	69		7 02		8.449	69	
319	Instr.	1.09	138		5 58		14.345	138	
Instr.	320	1.01	128		3 07		6.959	128	
320	Instr.	1.29	164		1 08		3.244	164	
Instr.	321	0.70	88		3 32		5.423	88	
321	Instr.	0.50	63	6 37		7.259		62	
Instr.	322	0.74	93		5 12		8.429	93	
322	Instr.	1.50	191		2 11		7.277	191	
Instr.	323	0.63	79		3 05		4.249	79	
323	Instr.	1.23	156		5 27		14.816	156	
Instr.	324	0.54	68		10 32		12.431	67	
324	Instr.	1.04	132		12 30		28.570	129	
Instr.	325	0.90	114		3 59		7.919	114	
325	Instr.	0.90	114		4 10		8.283	114	
Instr.	326	0.68	86		2 58		4.459	86	
326	Instr.	1.19	151		10 39		27.906	149	
Instr.	327	1.13	144		9 51		24.634	142	
327	Instr.	1.99	254		2 05		9.234	254	
Instr.	328	0.85	108		1 04		2.015	108	
328	Instr.	1.26	160		4 55		13.713	160	
Instr.	329	1.00	127	8 12		18.114		126	
329	Instr.	0.78	99		3 01		5.210	99	
Instr.	330	0.84	106		8 45		16.125	105	
330	Instr.	0.80	101		11 16		19.733	99	
Instr.	331	1.15	146		21 47		54.180	136	
331	Instr.	1.07	136		4 29		19.631	135	
Instr.	332	0.66	83	0 39		0.942		83	
332	Instr.	0.27	34		10 09		5.992	33	
Instr.	333	1.11	141		17 40		42.790	134	
333	Instr.	1.10	140		13 55		33.671	136	Pie de Nercua.
Instr.	334	0.76	96		1 24		2.345	96	